MISSOURI'S
SWAMP AND OVERFLOWED LANDS
AND
THEIR RECLAMATION

DECEMBER, 1912

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JOHN H. NOLEN

Special Agent of Missouri in Land Reclamation

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SWAMP AND OVERFLOWED LANDS

AND

THEIR RECLAMATION

REPORT OF
JOHN H. NOLEN
Special Agent of the State

MADE TO THE FORTY-SEVENTH MISSOURI GENERAL ASSEMBLY, JANUARY, 1913.

THE HUGH STEPHENS PRINTING COMPANY
JEFFERSON CITY, MO.

RELIEF MAP

OF

Missouri

SHOWING LOCATION OF ALLUVIAL DEPOSITS.

Made for Report
Prepared by

John H. Nolen

Special Agent of Missouri in Land Reclamation.

DECEMBER, 1912.

REPORT TO FORTY-SEVENTH GENERAL ASSEMBLY.

To the Senate and House of Representative of the Forty-seventh Missouri General Assembly:

As Special Agent of the State, appointed by the provisions of section 63, House bill 1,200 of the Forty-sixth General Assembly, I have the honor to submit to you the following report of work performed by me between April 21, 1911, at which time the act became effective, and December 31, 1912, together with discussions of various subjects relating to land reclamation.

The section above mentioned stated I was to be "Special Agent of the State and the commission," meaning the Missouri Waterway Commission. I reported in person to the chairman of said commission immediately after this bill took effect, and informed him I was ready to comply with the law. I was told to meet the Waterway Commission on May 5, 1911, which I did, and was then informed by the chairman that the commission had decided to notify the State Auditor not to honor any bills approved by me.

I began my work immediately under the legislative appointment, and continued the same without interference until October 31, 1911, at which time an injunction suit was brought by the Waterway Commission in the Cole County Circuit Court to restrain the State Auditor from paying my salary and expense accounts. A temporary restraining order was granted, but the court in April, 1912, decided the Waterway Commission had no power to maintain a suit. The temporary injunction was kept alive by order of the circuit court pending an appeal to the Supreme Court, which was taken by the Waterway Commission. The decision of the lower court was affirmed by the Supreme Court in July, 1912, since which time I have been able to continue my work without further hindrance.

This suit greatly handicapped me in my efforts to give assistance to the owners of swamp and overflowed lands. Not knowing what would be the outcome of the injunction suit, I was not willing to continue my

travels over the State and pay out my own money with no positive assurance that this money would ever be refunded. Consequently I was forced to conduct my work for nine months as best I could by correspondence from my office. In a few localities the landowners agreed to pay my bills in case the restraining order against the State Auditor was made perpetual, and I was thereby able to continue my field work in such places.

I have given assistance to the landowners in many localities where drainage or levee districts have either been incorporated or petitions for incorporation are now pending. These districts are as follows:

Drainage District No. 1, Bates county, containing 41,350 acres; right granted by court to incur additional indebtedness to finish work started some years ago.

Elsberry Drainage District of Lincoln county, containing 22,500 acres; incorporated and plans of drainage matured.

The Fabius River Drainage District embraces 11,600 acres in the east part of Marion county, along the Mississippi river. District incorporated and system of drains and levees adopted.

Plans for an additional district embracing 4,800 acres of land in Marion county agreed upon and articles of association for the incorporation of the district now pending in the circuit court.

Plans for the Malta Bend Drainage and Levee District of Saline county adopted and benefits and damages assessed by commissioners; 2,500 acres in district.

Cole Lake and Gilham Lake Drainage Districts of Saline county contain 4,750 acres. Organized by the county court and work progressing satisfactorily.

Articles of association for organization of Salt Fork Drainage District in Saline county being signed, and will be presented to the circuit court for action at February, 1913, term. District will contain about 6,000 acres.

Drainage ditch six miles long of the Valley Drainage District, Shelby county, is now under construction and will be completed in March or April, 1913. This district contains 4,708 acres.

St. John's Levee and Drainage District of New Madrid county; incorporated March 29, 1912, and contains about 75,000 acres of overflowed land along the Mississippi river. Surveys for the district are being made at the present time.

Work on the Adair County Drainage District completed October, 1912. It contains 6,306 acres.

A petition is pending in the circuit court of Cass county for the incorporation of 24,000 acres of land along South Grand river in Bates

and Cass counties into a drainage district. The matter will be acted upon by the circuit court of Cass county in January, 1913.

The board of supervisors of One Hundred and Two Drainage District in Nodaway county contemplate digging their ditch deeper and wider, and plans for this work are being matured. The district contains about 15,000 acres of land.

The foregoing enumerated districts embrace about 230,000 acres. Detailed descriptions of these districts will be found in another part of this report, to which the attention of the members of the Forty-seventh General Assembly are respectfully referred.

In addition to services rendered in these localities, I have given assistance in many other places, but so far no actual results have been accomplished. It frequently requires many visits to a locality and repeated efforts to awaken sentiment in favor of a reclamation project. It is believed the seeds sown in many places during the last two years will bring forth the desired results hereafter.

Besides the discussions of various subjects relating to land reclamation prepared by myself I have included a number of papers written by men who have had wide experience in work of this character, and who are eminently qualified in every particular to treat these subjects. Beyond doubt no other report ever issued in this country contained so much valuable and reliable information on land reclamation as will be found among these papers. It is believed their presentations of these matters will stimulate the reclamation movement in this State.

Brief accounts of the National Drainage Congress and the Missouri Drainage and Levee Association have been inserted, as the former has for its object the furtherance of the reclamation movement throughout the Nation while the latter is intended to promote the same in Missouri.

Respectfully submitted,

JOHN H. NOLEN,
Special Agent.

MISSOURI'S SWAMP AND OVERFLOWED LANDS.

The swamp and overflowed lands of the United States, amounting to almost one hundred million acres, were, in most part, from the early settlement of this country until recent years, considered not only worthless but a real burden to whatever division of government they belonged. Most of these lands in their original condition were useless because they could not be cultivated, neither could the heavy forests which covered much of such territory be utilized. These lands became the property of the Federal Government along with the desirable portions, because it was impossible to separate the one from the other, and so long as they belonged to the Federal Government Congress exhibited a tendency not only to neglect the responsibility due these lands but sought to free itself of them entirely.

What disposition to make of these swamp and overflowed lands, and how to rid the government of such an apparent nuisance, were perplexing questions over which the various sessions of Congress debated and wrangled for seventy years before a final solution was reached. An historical account of how the title to the swamp and overflowed lands of the country, by one sweeping act of Congress, were laid into the laps of the various states in which they were situated as gifts to such commonwealths, and how in turn within the shortest time possible these donations were passed on down to the counties that parceled them out to individuals, is worthy of space here, as it will convey some idea of the limited value placed upon these lands until recent years.

Congress in 1850 passed a bill donating all swamp and overflowed lands then belonging to the Federal Government to the various states in which they were situated. The pretext assigned in the bill for having thrust these lands upon the states was that "to enable the various states to construct the necessary drains and levees to reclaim the same," but there is good reason to believe Congress was only endeavoring to free the Federal Government of what was then considered a lot of worthless territory, much of which, it was supposed, could never be improved in any manner.

Missouri, as a result of this act, claimed title to 4,843,676.09 acres of land classed as swamp and overflowed, and the Federal Government approved claims amounting to 4,498,573.28 acres. Patents to 3,345,514.51 acres have been issued to Missouri, and land indemnity to 81,016.69

acres has been received and cash indemnity of $195,874.82 on 191,417.06 acres more. These lands for many years thereafter were a constant vexation to lawmakers, courts and various other state and county officers.

The President's signature to this bill had scarcely dried (his name having been affixed thereto September 28, 1850, when the Missouri officers began formulating plans whereby this State could dispose of this wondrous gift so suddenly bestowed. It was decided Missouri should be equally as generous in its acts as the Federal Government had been, for the Legislature passed a law March 3, 1851 (less than six months after Congress had donated the lands to the State), conveying the title to the lands thus received to the various counties in which they were situated, except those in the extreme southeast part of the State.

Another bill was passed by the same Legislature, creating a commission to have surveys made of the southeast swamp area not donated to the counties, and to devise plans to drain and reclaim this territory. Certain rules governing the acts and procedure of this commission were contained in the bill, and $50,000 was appropriated out of the general revenue of the State to carry into immediate effect the provisions of the act.

In 1852 the Legislature adopted a bill that donated the Southeast Missouri swamp lands retained by the act of the previous Legislature to the counties of which they were a part, and declared the functions and powers of the swamp land commission created and appointed by the former Legislature should cease, and that said board should wind up its affairs within a stated time and settle with the various State and county officers.

There are no records showing what progress, if any, had been made by this board in formulating plans for reclaiming this land. The Legislature of 1852 seems to have reached a very decisive conclusion within one year's time that the State should proceed no further in its efforts to drain and levee swamp lands, and made such work on the part of the State thereafter impossible by transferring the title to all lands reserved by the previous Legislature to the counties. It emphasized its sentiment and determination by ordering the $50,000 appropriated for use of the swamp land commission refunded by the counties in which the reserved lands were situated.

Missouri thus made rapid progress in disposing of its portion of the gift bestowed upon the states by Congress, for within two years after having received these swamp and overflowed lands this State had transferred title to the same to the counties, and delegated to them the reclamation work which Congress had assigned to the State. Like the

Federal Government, this State imposed upon smaller divisions of the government an obligation it would not perform itself.

The first act of the Legislature donating a portion of these lands to the counties of which they were parts stated the transfer was made "in order to provide for the reclamation of all overflowed and swamp lands which were granted to Missouri for that purpose, and the net proceeds from the sales of such lands, after defraying the expenses of drainage, reclaiming, surveying and selling the same, as herein provided, shall be paid into the county treasury and become a part of the school fund of the county."

The bill further stated that the several county courts were "authorized and *required,* so soon as practicable, to have said overflowed and

A typical swamp scene. Early lawmakers and pioneer citizens had just reason to believe the swamp lands of this country were worthless and a burden to their owners.

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No effort, so far as shown by the State records, was ever made by any county to carry into effect the provisions of this statute. Realizing that the swamp and overflowed lands would never be reclaimed so long as the counties must be depended upon to do the work, the Legislature

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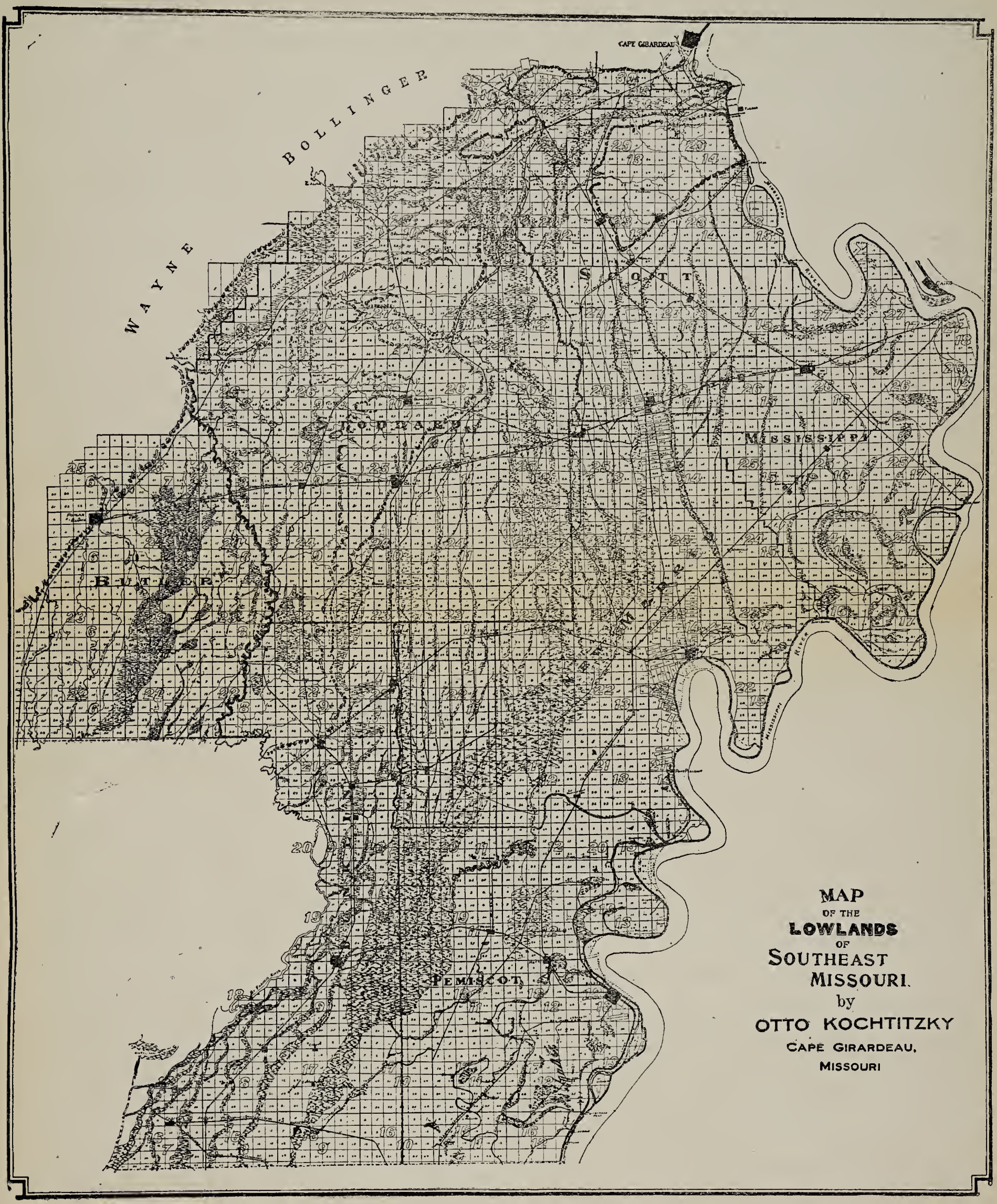
CAPE GIRARDEAU
WAYNE
BOLLINGER
SCOTT
MISSISSIPPI
BUTLER
STODDARD
PEMISCOT
MISSISSIPPI RIVER
MAP
OF THE
LOWLANDS
OF
SOUTHEAST
MISSOURI.
by
OTTO KOCHTITZKY
CAPE GIRARDEAU,
MISSOURI

of 1855 authorized the county courts to sell the lands "either with or without draining the same," in order that the counties might disencumber themselves of the burden these lands had proven to be.

Until the meeting of the Legislature in 1857 all counties except those constituting the extreme southeast part of the State had received titles to swamp land by virtue of the 1851 law, and the excepted, or southeast counties, by the act of 1852. The Legislature of 1857 repealed both of these acts and re-enacted a general law which provided that *all* swamp and overflowed lands received by the congressional act of 1850 should "be and they are hereby declared to vest in full title, and belong to the counties in which they may be." This statute remained in full force and effect until the revision of the laws in 1868, when the Legislature, in order to make the purpose and meaning of the statute more emphatic and the State's freedom from further responsibility to such lands doubly sure, declared that "*all of said lands in this State are hereby donated to the counties in which they may be respectively situated, and shall be the absolute property of such county for the purpose hereinafter designated.*" The purpose for which these lands were given was that of drainage.

This act simply confirmed to the counties the title which had been already granted to them by former acts, and the laws of 1868 and 1869, with a few amendments made by the subsequent Legislatures, are the present statutes of Missouri relating to titles of lands received under the congressional act of 1850. Many other states proceeded as did Missouri in disposing of the swamp and overflowed lands received by the same act of Congress, and thus evaded the obligations imposed upon them when the lands were presented to the states.

The foregoing minute and wearisome history of the labyrinthean evolution of Missouri statute relating to the titles of swamp and overflowed lands acquired by the congressional act of 1850 has been considered necessary by the writer in order to reveal the determination and concealed anxiety that existed among the various early Missouri legislative bodies to dispose of these lands without the State having to reclaim them. There must have been local opposition to the counties becoming the owners and thereby the redeemers of the swamp and overflowed lands within their bounds, else why should it have been necessary for the Legislature of 1868 to emphasize the fact that all such lands should be the *absolute property* of the counties, after they had been donated to the counties by former Legislatures. These facts are evidence that great antipathy must have existed in the minds of Missourians against lands of this character.

It must be admitted considerable cause existed for the belief that

the swamp and overflowed lands in Missouri were worthless and probably could never be reclaimed. A very large per cent of these lands were worthless when first received as a gift from the Federal Government, and they remained so until recent years. Large areas of these lands undrained were sold at sheriff's sale after they had been donated to the counties and brought only a few cents per acre. One body of 80,000 acres in Stoddard county sold for the small sum of $663.95 in 1868 at public sale, but the same land now is said to be worth from $75 to $100 per acre, for it has been drained and rendered tillable.

The insignificant sums for which many large tracts of these lands were sold under the law permitting the county courts to dispose of them

The duck hunters and frog-leg epicureans are grieved to see the swamps drained.

at either private or public sale bred dissatisfaction in many counties and furnished grounds for disappointed persons to accuse the courts of showing favoritism to certain purchasers. In order to prevent partiality as much as possible and protect the public welfare, the Legislature of 1874 passed a law limiting the minimum price for which these lands could be sold by the courts to one dollar and twenty-five cents per acre. This act had a tendency to check the sale of swamp lands for some time, and considerable areas remained in the possession of the counties until recent years.

The movement started in many counties about twenty years ago to drain and levee the most favorably situated wet lands in Missouri, and

MAP

Indicating

Overflow Land

IN

North Missouri

PREPARED BY

JOHN H. NOLEN

Special Agent of State in Land Reclamation

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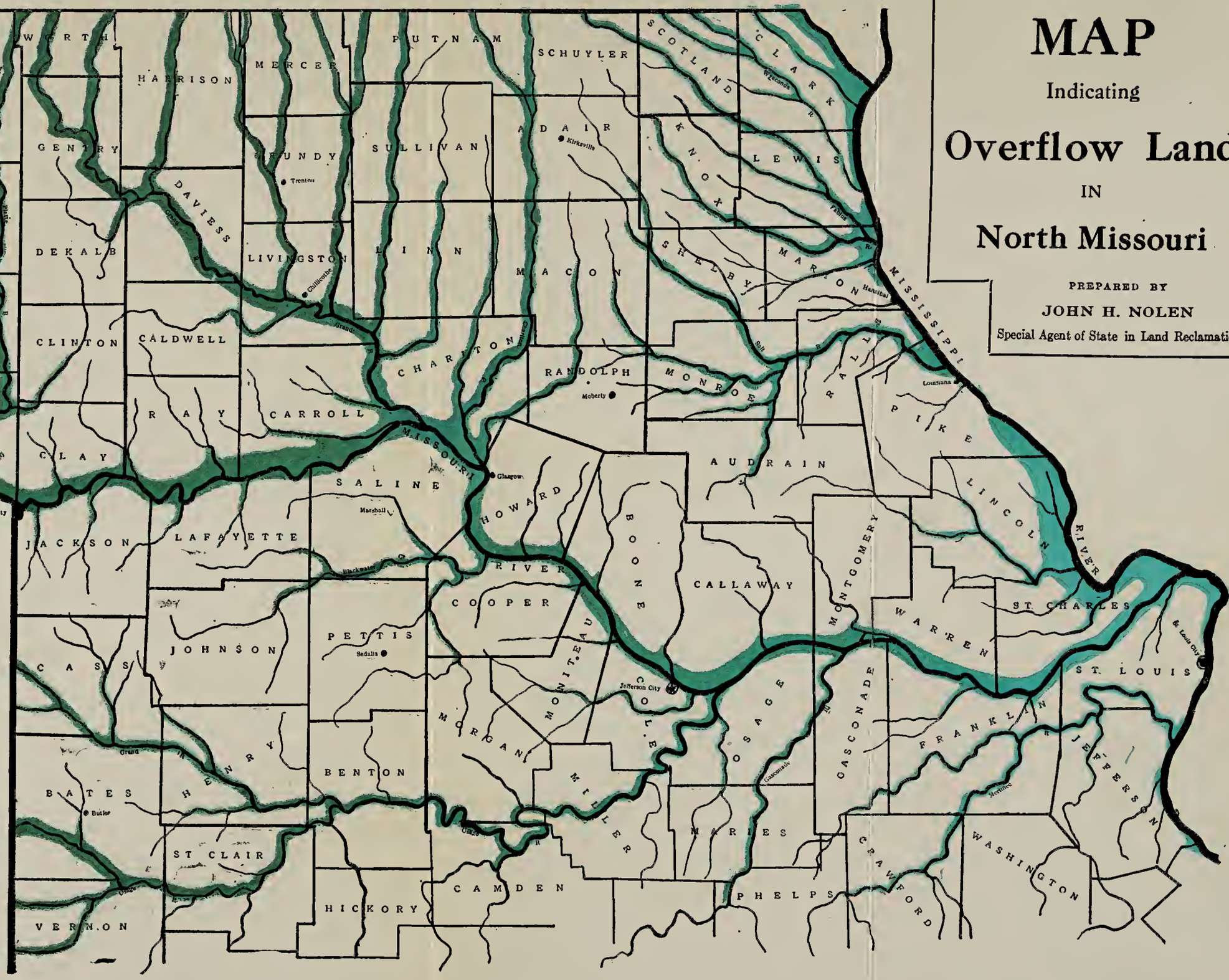


The above map indicates the overflow land of Missouri along the Mississippi and Missouri rivers and their tributaries in the north part of the State. The total overflow area shown by the blue tint of this map amounts to approximately 2,000,000 acres. Another map printed in this report shows the swamp and overflow land in Southeast Missouri. Overflow land is not extensive in many of the counties located in the southwest part of the State.

the success attained by the work, increased the demand for all such lands and brought forward purchasers who were willing to pay the minimum prices fixed by law, and thus enabled the counties to dispose of the major portion of their lands in rapid order.

The 3,345,514.51 acres of swamp and overflowed lands patented to Missouri by the act of Congress in 1850 do not constitute the full amount of such lands within its borders. The lands in this State that were originally either marshy or subject to periodical overflows amount to about four and one-half million acres. Not more than one-half million acres have been completely rescued so far by the various reclamation systems in use, leaving about four million acres yet needing attention.

Few pioneer citizens possessed sufficient foresight to forecast the increases that were to take place in the values of wet lands, but those who did anticipate such growths and invested their money in such lands at an early date have been copiously remunerated, except in very few localities. The transformations brought about and the immense increases in population and wealth that have occurred during the last twenty years in the localities where land reclamation has been carried on most extensively have been pointed out in another part of this report, under the chapter entitled "Land Reclamation Successful in Missouri," making further elaboration of this question unnecessary under this title.

The soil that constitutes the swamp and overflowed lands in this State is of such high quality as to entitle it to the greatest consideration possible. It is an alluvion in the strictest meaning of the word, for it has been transported from other parts of this country by the rivers and deposited in their valleys. It is a compound of all the best soil properties known to the world, and there is no land that surpasses its productiveness.

The Missouri river has annually gathered the disintegrated red granite—considered the most productive of all soils—from the Rocky Mountains, and skimmed the cream from the old lake beds of the western plains, while the Mississippi brought down the fertile soil from the forests and plains of the north; the Ohio river, during its course from the Appalachian region through the carboniferous beds of Pennsylvania, Ohio and other states, gleaned the best soil from the east and contributed its portions to the southeast part of the State. All this time the rivulets, branches and creeks of this State have been gathering the best of the Missouri soils from the hills and plains and poured them into the small rivers, to be deposited either in their valleys or carried on to those of the larger streams.

To all this has been added regularly a vast amount of vegetable matter, which has grown and decayed annually through these centuries

and which supplied the humus so prevalent in this deposit. This soil is, in most part, a sandy loam that responds readily to cultivation, and requires but little labor to grow a crop. It does not puddle or flocculate to any great extent. Portions that have been covered by water for untold centuries, after having been drained and allowed to receive the sun's rays for a short time, are easy to cultivate, and respond to the farmer's efforts with an abundant crop the first season. "The wetter the better" is a maxim in vogue among persons who have become experienced in land drainage, meaning that land can never become so heavily water-soaked as to destroy or even injure its agricultural qualities.

Missouri's alluvial soils are of higher quality than the same class of soils in most other states, and often more preferable. The rivers coming from the Rocky and Appalachian mountains are unable to carry the coarse grains of sand and other heavy substances a very great distance after leaving the mountain regions, because the currents are retarded by the decrease in fall of the streams; consequently the large particles which cannot be transformed into plant life are deposited along the rivers after they reach the plains, or more level country. The medium size particles of matter form very productive soils that can be cultivated easily, and are dropped usually along the middle sections of the rivers. The fine grains of soil continue with the water for a greater period and are deposited in the regions of the rivers' termini or are carried into the ocean. Missouri being situated half way between the sources and mouths of the two greatest rivers in this country, her portion of the alluvial soil contributed by these streams is composed of the medium size particles.

Speaking of the Missouri alluvial soil and what it is capable of producing, the writer, in a report prepared about two years ago, said in part:

"Instead of producing a few of the crops in moderate amounts, as is the case with most of the ridge land, the bottom soil will grow abundantly all vegetation climatically suited to Missouri. The alluvial deposits range in depths from a few feet along the small rivers of the State to as much as two hundred feet along the Missouri and Mississippi rivers and in the southeastern part of the State, and their productive powers are almost inconsumable.

"The inexhaustible supply and fertility of the Egyptian soil is no greater than the alluvial deposits of Missouri, because both have been formed in identically the same manner and possess practically the same properties.

"The cultivated area of Egypt is not more than six million acres;

Cypress forest of Southeast Missouri.

This picture illustrates the usual drifts and logs that abound among the swamps.

the population of the same country, according to the last census, was 9,734,405; after the wants of that vast number had been supplied by the land there remained a surplus of agricultural products valued at $15,575,025, which was sold to other countries. These exports were worth eleven per cent more than all the goods (chiefly manufactured) imported into Egypt during the same year. At the present time, in the valleys of Missouri streams, including the Mississippi river, are about 4,000,000 acres of overflowed and swamp lands that may be reclaimed or protected and made to produce as abundant harvests as were ever gathered from the fields of the Nile valley. In other words, the overflowed lands of this State alone are capable of sustaining the present population of Missouri, leaving the remaining forty million acres to supply the necessaries of life for the inhabitants of other states and countries.

"If the mediocre Egyptian farmers are able to sustain an average of three persons on every two acres of tillable land and have a surplus worth two and one-half dollars per acre to ship to foreign markets, ought not the Missouri farmers, with their superior intellects, greater diversification of crops, better farm animals, more modern implements, closer proximity to markets, a more desirable climate and better agricultural laws, on similar land, at least, do as well?

"The reclamation work in Holland may be cited as an example of what can be accomplished for a country by the use of dikes, levees and drainage. The name of that country signifies "hollow" or "low" land, for more than one-fourth of all the land in Holland lies below the level of the sea, and this class constitutes the most fertile and populous sections.

"Of the eight million acres in the Netherlands, only two and one-quarter million acres, which is equal to about two-thirds of the swamp and overflowed lands in Missouri, are being cultivated; half of the remainder is devoted to pasturage, where grass grows sparsely, and the remaining three million acres, composed of sand dunes, is void of vegetation except scrubby, worthless timber. Missouri has over forty-three million acres of land, which is five times the total land surface of Holland, but the latter country's population ten years ago was about five millions, while Missouri's inhabitants were a little more than three-fifths of that number. If the swamp lands of Missouri were located in Holland they would be soon transformed into productive fields that would startle the people of this State."

A great variety of crops can be grown on reclaimed land. This has been demonstrated by many fields that have been in cultivation for many years. Among these crops are the cereals, consisting of corn, oats, wheat, rye, barley and Kafir corn; then come the leguminous

plants, such as edible peas, beans, peanuts and cowpeas; the tuberous plants, consisting of Irish potatoes, sweet potatoes and artichokes; forage grasses, namely, blue grass, timothy, red and alsike clovers and alfalfa; vegetables of every known class and of many varieties; fruits and berries of at least a dozen classes and thirty varieties; added to all these are cotton, tobacco, hemp, flax, cane, nuts and many others.

The wet lands of Missouri are soon to become the most valuable of this State, because their extreme fertility after having been reclaimed is sure to attract the attention of progressive people. Truly they are going to constitute the State's bread basket, out of which the millions will be fed long after the other soils of the State have become exhausted.

A well improved Missouri farm where water stood before drainage was started. A swamp can yet be seen in the far distance of this picture.

The Creator seems to have intended these alluvial deposits as a sort of endowment fund, the fruits of which are to be enjoyed after the other soil heritages have been exhausted; they have been held in trust by nature all this time, and defended by the waters. Each year they have grown in magnitude, but the time has arrived for the present generation to receive from this endowment its portion of the annuities which will be supplied by these lands after being reclaimed, and it behooves us to see that we receive our portion of this magnanimous gift.

The reclaiming of this land means that the numerous disease-spreading mosquitoes, lakes, bayous, swamps, "hookworm" and other undesirable objects must give way to wells of pure water, domestic

animals, churches, schools, fields of waving grain, orchards, cities and modern dwellings occupied by industrious, frugal, intelligent, contented, happy people.

The men who are pushing forward the movement to have the four million acres of swamp and overflowed lands in Missouri reclaimed are laying the foundation for the most beneficent and enduring monument ever erected. Long after the hand of time has erased from view the other monuments this one will stand, and so long as mankind shall inhabit this State each succeeding generation will reverence the names of those who were instrumental in bringing about the reclamation of these precious lands. It is not an obelisk of stone they are preparing by the reclamation of these lands, to erect in Missouri to please the oculary sense and commemorate some deed of valor performed by the shedding of blood on the field of battle, but one signifying happy, comfortable homes, food and raiment for the future generations, and one that will last until man shall inhabit this earth no more.

Congress by donating the swamp and overflowed lands of this country to the various states, and the Missouri Legislatures by handing this State's portion of these lands on down to the counties, because it was believed the same were worthless and could never be reclaimed, dissipated the richest soil the world has ever known, the soil that is soon to become the most valuable.

Surely "The stone which the builders rejected the same is become the head of the corner."

Melons growing on reclaimed land.

LAND RECLAMATION SUCCESSFUL IN MISSOURI.

Missourians are no longer compelled to point to the land reclamation work in Holland and other countries to illustrate what can be accomplished by the construction of dikes, levees and drains. Most of the soil drained and leveed in this State furnishes conclusive evidence that land reclamation can be prosecuted successfully where proper conditions prevail and when scientifically planned, and that it will richly reward those willing to invest their means and devote their time and energies to work of this character.

While not all such enterprises undertaken in this State have come up to the expectations of landowners, who too frequently allow their enthusiasm and imaginations in this mighty work to override their judgment, a complete failure probably never occurred in a single Missouri district, and instances have been extremely rare where the total benefits derived from the drains and levees of the districts have not equaled the cost incurred. The work in the pioneer districts has been found least effectual; this is true especially of the districts established in the narrow valleys of small streams. The area taxed to pay costs in such districts was often insufficient to provide funds without burdening the lands, and reclamation problems were extremely complicated and difficult to solve.

The total benefits derived by Missouri wet lands from the drains and levees constructed for their relief during the last score of years have exceeded the cost of such improvements at least tenfold. Most of these lands in their original condition possessed no real worth, for they supplied none of the necessaries of life, and their present values are due largely to improved conditions brought about by the various reclamation systems.

Land reclamation in Missouri has achieved its highest degree of success in the southeast part of the State, where the greatest overflow area abounded and where the work was started about twenty years ago. The majority of inhabitants of the seven extreme Southeast Missouri counties, namely, Butler, Dunklin, Mississippi, New Madrid, Pemiscot, Scott and Stoddard, and those residing in the overflowed portions of Bollinger, Cape Girardeau, Ripley and Wayne, at present are more concerned in relieving the remaining portion of their wet lands of water

Cowpeas are a paying and certain crop when planted on reclaimed land.

This wheat field has replaced a swamp.

Alfalfa waist high growing on land originally covered by water.

troubles than they are in any other subject. It is a question of supreme importance to them, for success in this means great reward, as has been demonstrated by the many adjoining fertile fields now in cultivation from which the excessive waters of recent years were banished at small cost.

To appreciate thoroughly the wonderful transformation that has been wrought in this overflowed region one must know conditions as they were before drainage and levee work was begun, and compare original with present conditions.

So extensive were the swamps in Southeast Missouri a score of years ago that that portion of the State was usually denominated "swamp east" Missouri by citizens of other parts, and the title was not inappropriate, for a large per cent of the land was either marshy or subject to frequent inundations of the Mississippi and other rivers. Of the 2,572,800 acres composing the seven southeast counties heretofore named, 1,858,122.92 acres were received from the Federal Government under what is termed the Swamp Land Act of 1850, which conveyed titles to all wet lands in this country to the various states in which they were situated.

It will be observed that almost three-fourths of the Southeast Missouri area in its original condition was unfit for habitation and cultivation. This was not the only impairment the country suffered, for the atmosphere which the swamps polluted was a menace to not only the inhabitants who lived on the elevated ridges of the overflow and swamp territory, but likewise to those residing on the hill land bordering on the swamps. The early health conditions of this land were not such as to encourage the incoming of the best citizens. Malaria, which is now known to be due directly to the mosquito that breeds in the stagnant waters, was prevalent everywhere, and its ravages had a telling effect on the health and happiness of the people.

Schools were scarce and difficult for the children to reach because of the swamps that often lay between the schoolhouses and homes. The religiously inclined were not always afforded convenient opportunity to worship, owing to the scarcity of churches and the inability of the inhabitants to support ministers of the gospel.

Most of the magnificent forests of gum, spruce, poplar, oak and other varieties of valuable timber seemed impregnable at first, as they stood entrenched among the swamps, and in many localities where they were procurable their long distance from railroads or inconvenience to market rendered them worthless. Public roads were few and far between, and such as existed were impassable much of the time.

Four main lines of railroads traversed this territory in 1890, afford-

ing transportation facilities to only a limited portion of the country. Pemiscot county at that time had no railroad within its borders.

Prices of land subject to cultivation were at low ebb, and most of the overflowed or swamp lands had no values, as is evidenced by the fact that many large tracts which were sold at public action brought only a few hundred dollars.

The cities and towns were scarce and most of those in existence were of little importance. Poplar Bluff, in Butler county, with 2,178 population in 1890, was the metropolis of the seven counties comprising the swamp area, and Charleston, Mississippi county, second in size, had 1,381 inhabitants. New Madrid ranked third with 1,193.

The foregoing facts convey only a faint idea of conditions as they existed in 1890, or before reclamation work was begun. Present conditions reveal the important changes that have taken place since the people began constructing drains and levees.

About seven hundred thousand acres in Southeast Missouri have been influenced by these two classes of improvements; most of this land has been completely reclaimed and is suitable for cultivation at all times. The cost has ranged from three to six dollars per acre.

Harvesting wheat where a few years ago swamps existed.

The results of the reclamation work have greatly improved health conditions, and they now compare favorably with those of other localities in this State.

The increase in population of these seven counties from 1890 to 1910, as shown by the federal census, was 88.7 per cent, while the increase in

the other one hundred and seven counties and the city of St. Louis was 20.7 per cent. The former increase was more than four times the latter.

The assessment of real estate in these seven counties was increased, according to the State records, 221 per cent during this period; the increase in assessment of like property in the remaining part of the State was 76.5 per cent.

The value of the surplus products shipped from these counties in 1910 was two and one-third times the value of the same classes of commodities sent to market in 1900.

The amount expended for public schools in 1910 was 292.5 per cent greater than the sum paid for like purposes in 1890; the increase in the other counties of the State and the city of St. Louis was 49 per cent.

The mileage of railroads in these seven counties increased more than 200 per cent in twenty years, and the present mileage exceeds that of any other seven contiguous counties in Missouri.

The growth of the towns in this territory was marvelous. Poplar Bluff sprang from 2,187 in 1890 to 6,916 in 1910, a growth of almost 250 per cent. Sikeston had 636 inhabitants in 1890 and 3,327 in 1910, a growth of over 500 per cent. Kennett grew from 302 to 3,032, or 1,000 per cent. Bloomfield was too small in 1890 to be incorporated as a town, but had 1,147 people in 1910; Charleston went from 1,381 to 3,144; Dexter from 792 to 2,322; Hayti from an unincorporated town to 1,052; Malden from 905 to 2,115; New Madrid from 1,193 to 1,882. Numerous other towns sprang up over this country and are now important trading points with populations ranging from 250 to 1,000.

Not one town, large or small, in these seven counties suffered a decline in population from 1890 to 1910, and there are manifestations of a greater growth of all towns in both wealth and population during the present census period than was experienced during the previous two.

Sikeston, situated in the heart of the reclaimed portion of this territory, is said to be the wealthiest town of its size in the United States, and many other towns are noted for their thrift, numerous industries and unusual wealth.

Cape Girardeau, located on the elevated land a few miles north of this swamp territory, increased 100 per cent in population from 1890 to 1910, and much of its growth can be traced directly to the improved conditions brought about in the overflow territory just south of it.

Land in Southeast Missouri produces more cotton per acre than is grown on any other land in the United States, and Southeast Missouri cotton is rated the best on the market on account of its fine, long fiber. The seed is in demand for southern planting because of its hardiness and certainty of growth when planted. The boll weevil that has been so

disastrous to cotton growing in states further south has never made its appearance in the Missouri fields. This is principally due to the insect's inability to endure the Missouri winters.

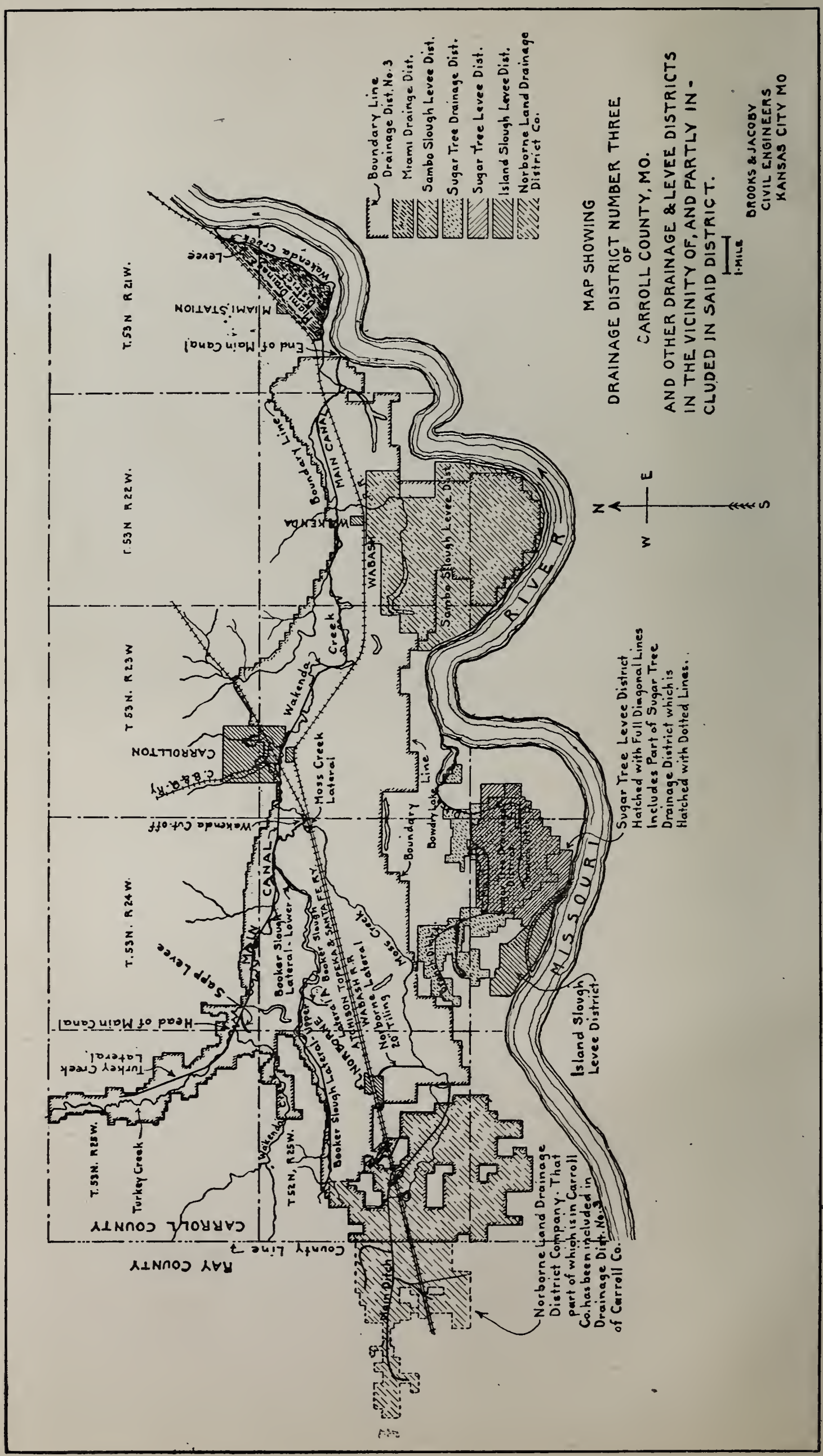
Corn growing on newly redeemed land in Southeast Missouri. It produces from 60 to 90 bushels per acre.

The changes that have been wrought in the Southeast Missouri overflow area during the past twenty years is only a beginning of what is predicted for that country during the next twenty.

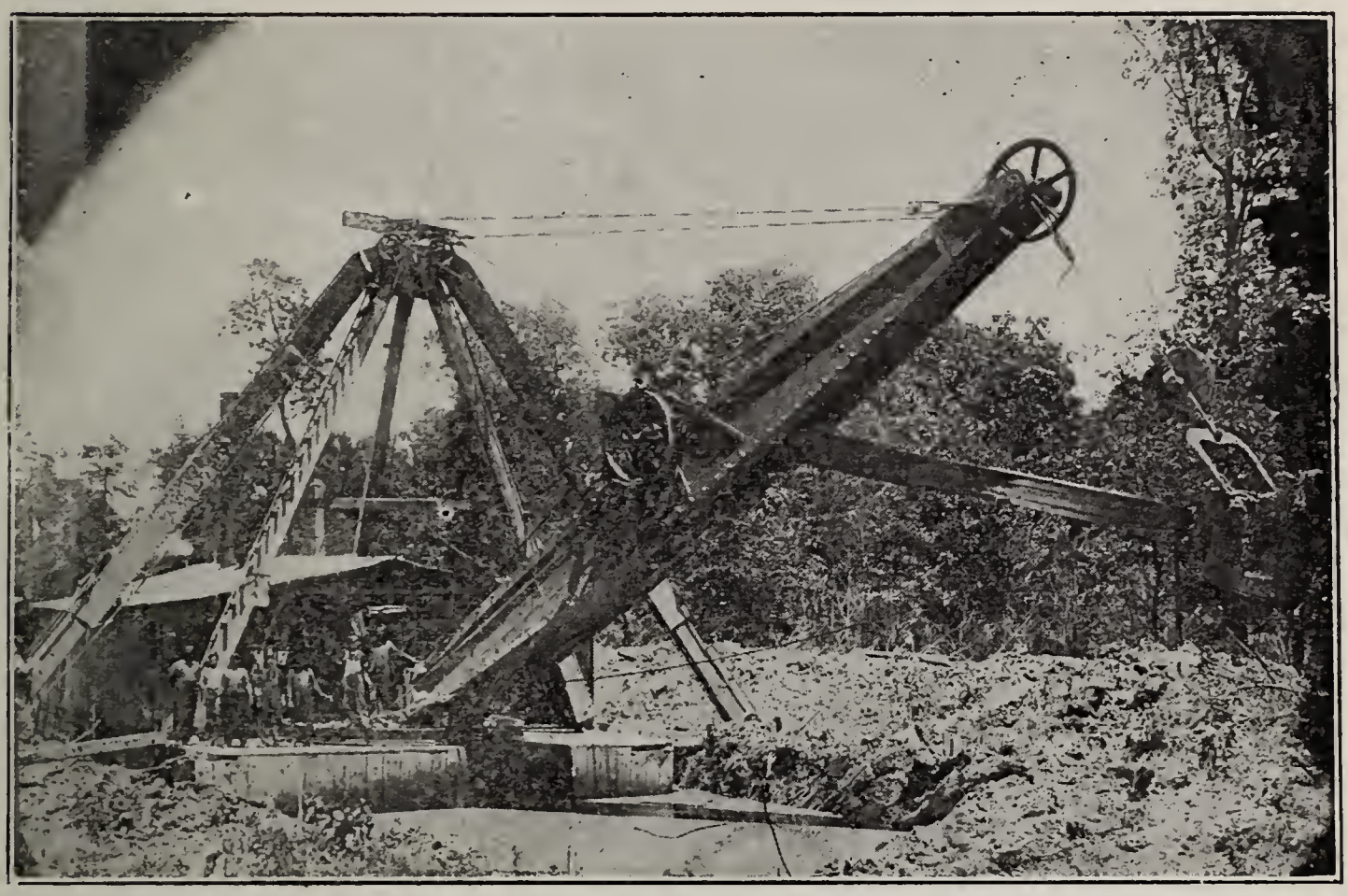
The Little River Basin, already organized into a drainage district, embraces 560,000 acres. The St. John's Basin contains 450,000 acres of swamps located in the eastern parts of Scott, Mississippi and New Madrid counties. In the Saint Francis River valley are 350,000 acres, and 200,000 acres more are scattered throughout the other swamps of that territory.

These four divisions make a total of approximately 1,500,000 acres of swamp lands yet in Southeast Missouri, which is more than twice the amount already reclaimed. A large per cent of this 1,500,000 acres can be drained and leveed, and this will be brought about within the next five years. When this work has been completed a more stupendous growth in wealth, population, education, religion and happiness will occur in the following ten years than has taken place during the last twenty.

While it is admitted the increase in population and material wealth


MAP SHOWING
DRAINAGE DISTRICT NUMBER THREE
OF
CARROLL COUNTY, MO.
AND OTHER DRAINAGE & LEVEE DISTRICTS
IN THE VICINITY OF, AND PARTLY IN-
CLUDED IN SAID DISTRICT.
1-MILE
BROOKS & JACOBY
CIVIL ENGINEERS
KANSAS CITY MO
Boundary Line Drainage Dist. No. 3
Miami Drainage Dist.
Sambo Slough Levee Dist.
Sugar Tree Drainage Dist.
Sugar Tree Levee Dist.
Island Slough Levee Dist.
Norborne Land Drainage District Co.
N
S
E
W
T.53N R21W.
T.53N R22W.
T.53N. R23W
T.53N. R24W.
T.53N. R25W.
T.52N, R25W.
MIAMI STATION
Miami Drainage District
Levee
Wakenda Creek
End of Main Canal
MAIN CANAL
Boundary Line
WAKENDA
WABASH R.R.
Sambo Slough Levee Dist.
RIVER
MISSOURI
Wakenda Creek
CARROLLTON
C.B.&Q.Ry.
Moss Creek Lateral
Wakenda Cut-off
Boundary Line
Bowdry Lake
Sugar Tree Levee District
Hatched with Full Diagonal Lines
Includes Part of Sugar Tree
Drainage District which is
Hatched with Dotted Lines.
Island Slough
Levee District
Booker Slough Lateral - Lower
Booker Slough Lateral - Upper
Booker Slough
ATCHISON TOPEKA & SANTA FE RY.
WABASH R.R.
Norborne Lateral
Moss Creek
Norborne 20" Tiling
Head of Main Canal
Sapp Levee
Turkey Creek Lateral
Turkey Creek
Wakenda Cut-off
CARROLL COUNTY
RAY COUNTY
County Line ?
Main Ditch
Norborne Land Drainage District Company. That part of which is in Carroll Co. has been included in Drainage Dist. No. 3 of Carroll Co.

of the seven Southeast Missouri counties has not been due entirely to land reclamation, that work has been the principal factor in bringing about the development witnessed in that portion of the State. It has induced railroad construction, caused prices of all lands to increase, made it possible to harvest and market the valuable timber and in various other ways assisted in unfolding the marvelous natural resources of that country.



The machine that transforms swamps into happy homes and productive fields.

What has been said about the reclamation work in Southeast Missouri and the benefits resulting therefrom applies to certain other parts of this State, especially to localities of Holt and Atchison counties, where many drainage districts were organized some years ago and the efficiency of their systems thoroughly tested. The overflowed areas in other sections of this State are not so extensive as that of Southeast Missouri, but the soil of such lands, wherever found, is rich and inexhaustible, and some of the most productive fields in other parts of Missouri were swamps until the citizens constructed new and more direct channels for the small streams and levees to keep back the waters of the large rivers.

Land reclamation in its various phases is in progress in all the overflowed parts of Missouri and will not cease until all the land subject to relief has been redeemed. With better laws to guide them, experts to plan systems of reclamation and more improved machinery to construct

drains and levees, it is predicted the landowners will push forward rapidly hereafter in this important movement.

Harvesting alfalfa on drained land.

LAND RECLAMATION BENEFITS PUBLIC ROADS.

The construction and maintenance of public roads in many localities of Missouri depend very materially upon the drainage of the swamp lands that exist in these places, as the soggy conditions of the land must be abolished before permanent roads can be built successfully and at reasonable cost. It was an impossibility to construct good roads in the prairie sections of Missouri until the primeval lands had been subdued by drainage, cultivation or close pasturing and the marshy places thereby exterminated.

In Southeast Missouri are some very large swamp areas where road building has been rendered impossible. Beginning in the southern part of Cape Girardeau county at the Ozark foothills, and extending south through Missouri a distance of more than ninety miles, thence into Arkansas almost one hundred miles, is located a vast overflow area, ranging from six to twenty miles wide. The Missouri portion of this land is termed the Little River Basin and consists of more than half a million acres.

Owing to its extremely swampy condition roads suitable for travel at all times have never been maintained across this immense country. Before the Civil war a "plank" road was built from Point Pleasant, in New Madrid county, to Clarkton, in Dunklin county, by private parties, and toll was charged for its use. Federal troops burned the timbers during the Civil war, but it was reconstructed afterwards by covering it with poles, and it thus became known as a "corduroy" road. It was abandoned entirely some years ago. A road which can be traveled only in unusually dry seasons extends from Dexter to Morehouse, and is the only passageway across this valley at present.

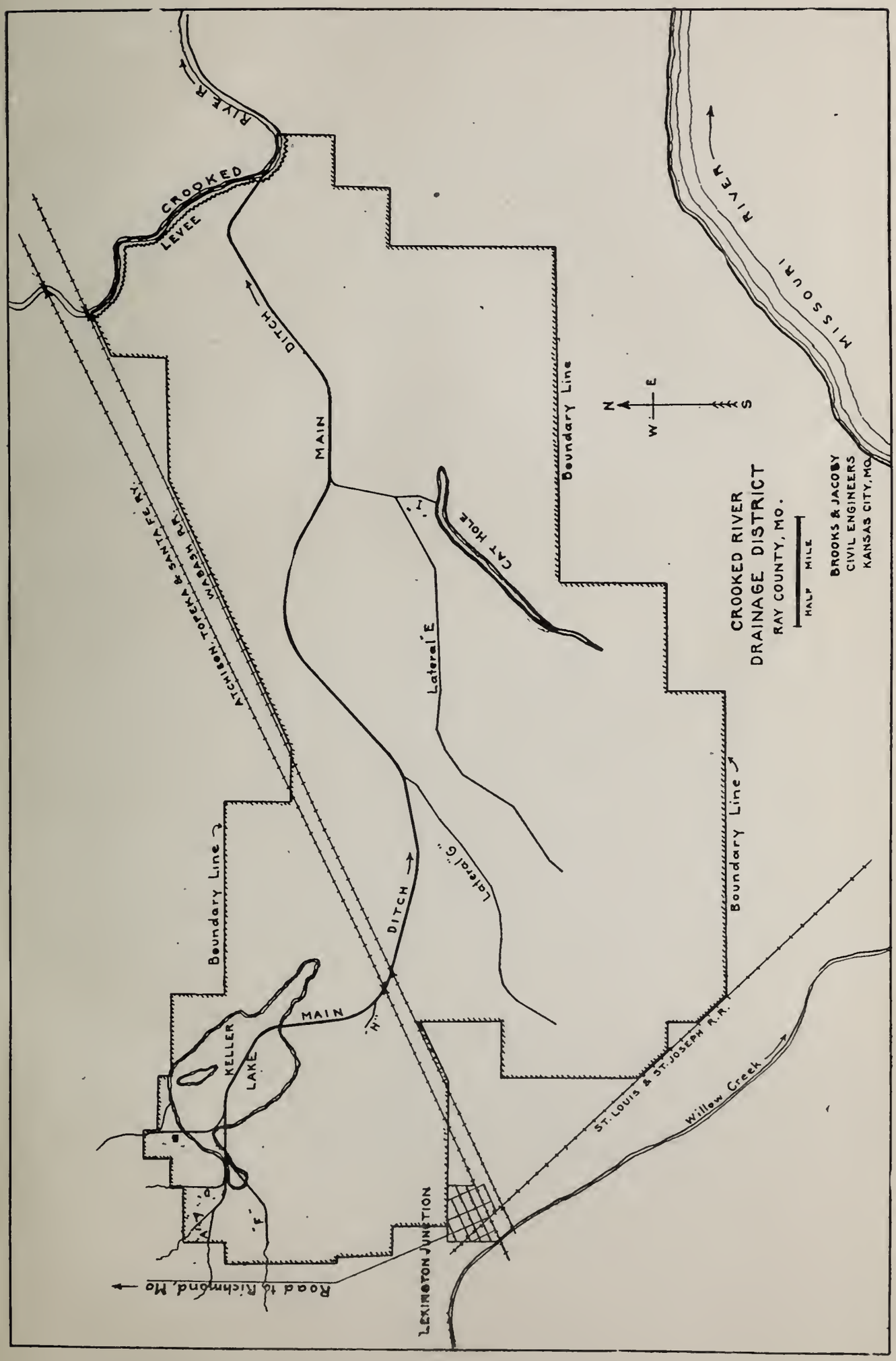
Travel other than by the railroads at all times from Dunklin to the adjoining county of Pemiscot, on the east, must be by a circuitous route up the west sides of the Little River Basin along Crowley's Ridge, through Dexter, Bloomfield and other towns; thence across Hickory Ridge and through the swamps south of Cape Girardeau. At this point one must turn down Sikeston Ridge, which affords suitable travel most of the year, and continue south for more than fifty miles to reach Pemiscot county. Such a tour covers at least one hundred and twenty-five miles and must be made over undesirable roads most of the distance.

This awful barrier to road building is soon to be removed, thanks to the energetic and enterprising citizens of Southeast Missouri, for the organization of the Little River Drainage District has lately been completed and work of actual construction will be started soon. The system of drains and levees adopted will completely relieve the Missouri portion of this land and render it more sanitary and suitable for road building purposes. A description of this drainage district, accompanied by a map of the same, will be found at another place in this report.

Class of steel bridge being constructed across drainage ditches in Stoddard county.

Another contiguous area of swamp land, embracing about four hundred thousand acres, is located in the eastern portions of Scott, New Madrid and Mississippi counties, through which but few roads have been constructed; vast areas of similar lands are found also in Butler county. Plans that will reclaim most of these two areas are being matured, and this land will soon be added to the list over which roads can be built. When these two systems, along with that adopted for the Little River Basin, have been put into effect, road building in Southeast Missouri is certain to be pushed at a rapid rate.

The owners of land in a drainage district or the persons residing therein are not the only citizens of a community in which a district is located who reap a benefit from the bettered condition of the highways resulting from draining the overflow land. Every inhabitant who travels these roads, no matter where he resides, and though he uses them only


CROOKED RIVER
DRAINAGE DISTRICT
RAY COUNTY, MO.
HALF MILE
BROOKS & JACOBY
CIVIL ENGINEERS
KANSAS CITY, MO.
MISSOURI RIVER
CROOKED RIVER
LEVEE
DITCH
MAIN
Boundary Line
CAT HOLE
Lateral E
Lateral G
DITCH
MAIN
KELLER LAKE
Boundary Line
Boundary Line
ATCHISON, TOPEKA & SANTA FE R.R.
WABASH R.R.
ST. LOUIS & ST. JOSEPH R.R.
Willow Creek
LEXINGTON JUNCTION
Road to Richmond, Mo.
N
S
E
W

occasionally, is the beneficiary of their improved condition. The farmers residing on the elevated land near a drainage district, who are compelled to use the roads that traverse the reclaimed land for either commercial or social purposes, will evidently find travel more profitable and enjoyable than it was before the land was drained.

The flooded condition of many valleys in this State frequently constitute impassable barriers between the farms on one side and the cities or trading points on the other. During such flood periods these farmers are unable to reach the towns to market their products or purchase the necessaries of life, and often they sustain pecuniary losses or are deprived important home comforts. The business of the merchants in these towns suffers because of the farmers' inability to reach the towns and purchase the merchants' wares. The prevention of this reciprocity of losses to nonlandowners in a community by the removal of the swamps or by the stoppage of prolonged overflowed periods, which result from the works of a drainage district, is an argument in favor of the public paying for bridges made necessary by the ditches of the district. The landowners in the district pay for having the swamps removed and the floods prevented, and it is held that the public in general should contribute a small portion of the cost by building the bridges.

Much enthusiasm has been aroused in Missouri during the last few years in favor of improving the public highways of this State, and every one is entitled to full credit and commendation for all the encouragement or assistance he has given this movement, but the persons who have assisted in draining the wet lands of this State have accomplished as much for road building and improved highways as any other class of people. Most of the proposed State highways across Missouri must pass through certain sections of swamp or wet lands, and permanent road building in such localities will be a difficult task until the owners drain the same.

The men who are draining the swamps and thereby improving the roads or making it possible to build them are doing so at their own expense, while the good roads advocates in other parts of the State are clamoring for public funds to put into effect their ideas.

PUBLIC HEALTH IMPROVED BY LAND RECLAMATION.

The drainage of the swamp lands in Missouri will have an important bearing on the general health of the people residing within and nearby this territory. The early inhabitants, and even those of later periods, who resided in the flat prairie sections of Missouri, where abounded marshes in which the mosquito laid its eggs and hatched the young, suffered greatly from a peculiar disease, at that time termed chills, fever and ague, but now known as malaria. This disease until recently was attributed to the decaying rank vegetation that existed everywhere. The cost of quinine consumed until recent years by the people in these localities almost equaled the amount they paid for flour.

As these lands were gradually brought under cultivation and the marshes and wet places eradicated, the chills, fever and ague subsided, so that now manufacturers of quinine, chill tonics and like medicines find little sale for their products in these localities.

The present inhabitants of this land enjoy better health and live much longer than did the previous generations. They are able to do better work and more of it than could their forefathers. All of these improved conditions have been accomplished by eliminating the marshes that were the breeding places of the disease-carrying mosquito, now known to be the direct cause of all malaria, which disease claims many thousand Missouri lives annually as its toll. In addition to the deaths caused directly by malaria, many others can be traced indirectly to it. A human body, enfeebled by the ravages of malaria germs, becomes an

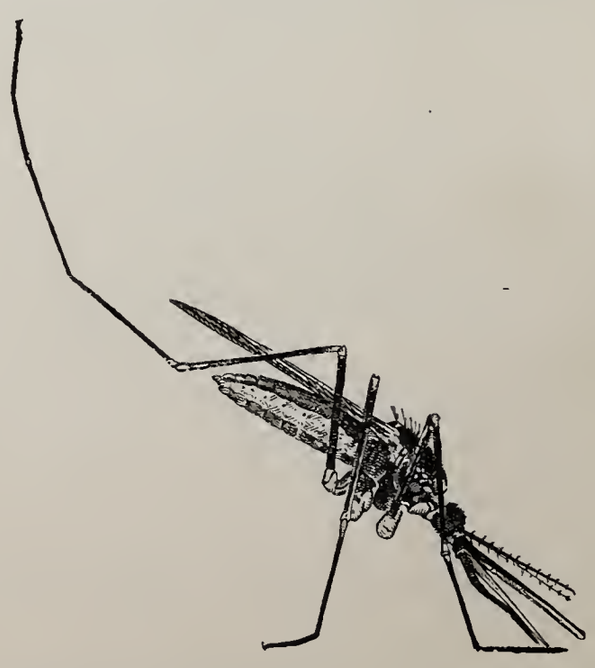
Male and female Anopheles quadrimaculatus mosquito, which produces malaria in the low marsh districts. Their breeding places will be destroyed by draining the swamps of this State and the disease eradicated thereby.

easy prey for tuberculosis and other deadly maladies. The cost of medicines and medical service, and the monetary loss due to inability to work while suffering from malaria, are important items to be considered. The suffering that must be endured under such conditions detracts greatly from the pleasures of life.

The improved health conditions that have been brought about in all parts of Missouri during the last quarter of a century are more directly due to the drainage of the swamps and marshy places of the State than to any other cause. Thus it is shown that land drainage is not to be undertaken for agricultural purposes alone, as the improved sanitary conditions resulting from the reclamation of the wet lands in this State is of vital interest to the general public, and that alone will be worth far more to the people of Missouri than the total cost of reclaiming the four million acres of swamp lands in this State.

It has been conclusively demonstrated that malaria can be exterminated by destroying the breeding places of the mosquito. The results attained in the Panama Canal Zone prove this. When the United States Government undertook the herculean task of constructing the Panama Canal the first movement decided upon was to drain the swamps and marshes in and near the Zone, as they were known to be the breeding places of the mosquitoes, which produce both yellow and malaria fevers that prevailed everywhere. As a result of this work, both diseases have been eradicated so successfully that not a case of either typhoid or yellow fever has been known for more than three years in the zone.

It was not the towering volcanic ash heaps at Culebra and other points along the Panama Canal route that defeated Ferdinand de Lessips, backed not only by his native country, France, but by the entire civilized world, in his efforts to construct a Panama Canal a third of a century



The female Anopheles mosquito is shown here in its characteristic stinging position.

ago. It was the mosquito which injected its poisonous virus into the veins and killed the skilled engineers and other workmen.

The "anopheles" class of the mosquito family carries the malaria-producing germs and injects the same into the human system, and is of most interest to the people of Missouri.

It has been found that often as many as twelve generations of the "anopheles" are produced in a single summer, and since one female will lay many thousand eggs in a season it is impossible to calculate the rapidity of their increase. Extreme temperatures will not destroy them. They thrive in hot weather, but after having been hermetically sealed up in a cake of ice all winter they emerge in the spring as lively as though they had spent the winter in a warm place.

Could malaria once be abolished from the human system there would be none for the mosquito to carry, as that insect is the intermediary host that transfers the poisonous malaria fever germs from one human being to another; or, could the mosquito be exterminated, this disease would not exist after the present generation had passed away, as it would no longer have an intermediary host.

It will be seen that every unselfish citizen of Missouri should be interested in the reclamation of our wet lands, because of the bearing it will have on the public health. This work, when completed, will result in increasing the average length of life of our people, prevent much suffering, prove a financial saving and make it possible for the inhabitants to perform more work.

SYSTEMS NOT INDIVIDUAL DISTRICTS PREFERRED.

Experience has proven that more thorough and extensive results in land reclamation can be accomplished by organizing the entire overflow area in a valley or basin into a single district and planning one general scheme for the relief of all the land than can be attained by dividing the same territory into a number of small separate districts possessing individual plans and having different corps of officers to administer their affairs independently. The former method has also been found more economical in many places, as often less works are required for one general system than for a number of small schemes covering the same territory. Furthermore, it often occurs that protection and relief can be supplied to considerable tracts of land that can not be reclaimed if individual districts are formed.

While the system method possesses certain advantages and should be followed wherever possible, physical conditions and differences of opinion prevailing among the landowners frequently preclude the possibility of bringing all the land into one district. The sentiment in favor of reclamation where the area is extensive does not always exist among those who own a majority of the land, rendering it impossible under such conditions to organize all the land into one district. In such cases those favoring the improvement of their property will be forced to either form districts containing only such lands as are owned by persons who will support the movement or continue without protection. Whenever possible organize drainage or levee systems, divided into small corelated units administered under one set of officers, but form individual districts rather than fail to secure relief for part of the land in some manner.

Small districts often prove injurious to adjacent territory, as their levees impound the water upon other lands. The increased volume of water that flows through ditches or new channels of small districts often causes other territory lying below such districts to be flooded and thus works injury to these lands. This can frequently be prevented under the system method, and in many instances such lands can be included in the large district and provided protection.

The foregoing facts have been demonstrated in a number of places, and a few examples will illustrate where and why they occur.

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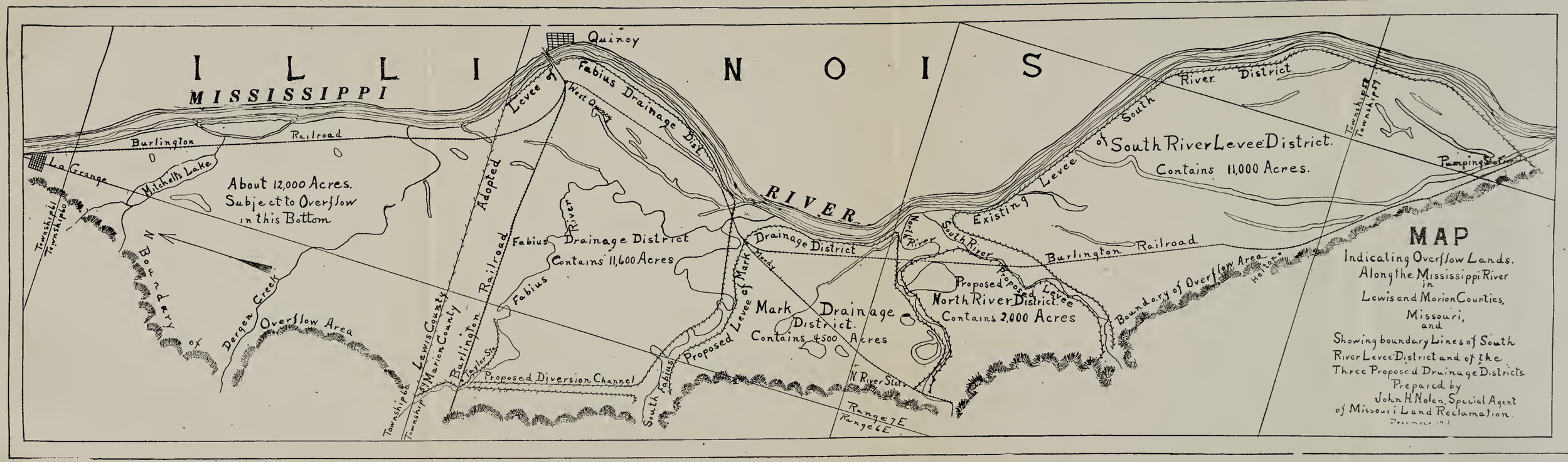


MAP

Indicating Overflow Lands.
Along the Mississippi River
in
Lewis and Marion Counties,
Missouri,
and
Showing boundary Lines of South
River Levee District and of the
Three Proposed Drainage Districts.

Prepared by
John H. Nolen, Special Agent
of Missouri Land Reclamation
Department, 1912

For many years much drainage work has been carried on in the Little River Basin of Southeast Missouri, and considerable portions of that vast overflow region, comprising more than half a million acres, have been reclaimed by forming separate districts, but the area improved by such work comprises only a small part of the whole.

The impossibility to reclaim the remaining portions of wet lands in that valley without incorporating all of it into one immense district and formulating one scheme of reclamation was recognized years ago, and this led to the organization of the Little River Drainage District and the adoption of its plans, which will hereafter prevent outside waters from overflowing the valley and furnish internal drainage for the land. A detailed description of these plans, accompanied by a map of the district, will be found in another part of this report.

A movement is now on foot to treat all the wet territory of St. John's Basin, located east of Sikeston Ridge, in Scott, Mississippi and New Madrid counties, Missouri, in like manner by fashioning all this land—comprising close to half a million acres—in one district, and evolving a scheme that will not only supply protection against the flood waters of the Mississippi at all times, but furnish a complete system of internal drainage as well.

Present conditions existing in what is often termed the "West Quincy Bottom," embracing about 40,000 acres of overflowed land located along the Mississippi river in the north part of Marion and the south part of Lewis counties, Missouri, and extending from LaGrange almost to Hannibal, a distance of about twenty-two miles, illustrate the importance of this matter. One levee district containing 11,000 acres of this land has been in operation during the last eight years, and three others are being formed. The four will comprehend little more than one-half the overflow land in that locality, but the amount spent to supply protection for this area would have provided adequate levees, drains, pumping stations and other works for the entire 40,000 acres had a single district been formed and one system of reclamation developed. A map of this territory, indicating the existing and proposed levees, is printed between pages 33 and 34 of this report.

These conditions have been brought about by one levee district having been formed some years before reclamation sentiment could be awakened among the owners of the other lands in the overflow territory; they are also due to the failure of landowners to co-operate in a movement to bring all the land into one district, and the opposition or indifference of others to any and all schemes.

There are yet a number of large tracts of swamp land in Missouri

that ought to be treated as a whole in planning for their redemption, because better results will be accomplished, more land will be improved and the average tax per acre reduced thereby.

Missouri's annual corn crop has been increased at least ten million bushels by land reclamation.

SOLVING DRAINAGE PROBLEMS ALONG SMALL STREAMS.

Experience has demonstrated the fact that it is much easier to formulate drainage systems that will prove successful for the wet lands in the wide valleys along the large rivers than it is to design plans that will even partially prevent overflowing and relieve the wet lands along small streams. Land reclamation has been in progress in Southeast Missouri, where the overflow area ranges from a few to many miles in width, for almost two decades.

When the inhabitants of that portion of the State began this work they were inexperienced and were compelled to proceed with only crude laws for their guidance, and generally on untried plans; most of their work was experimental at first, as they were pioneers in the drainage movement and had to "blaze the trail" for others to follow. The engineers made but little or no effort to secure data relating to the usual rainfall, watershed and run-off of the districts. The necessary carrying capacity of the drainage ditches received but little consideration; their sizes usually depended upon the amount the landowners in the districts were disposed to invest in such enterprises. Much of the information now considered important in planning a successful drainage system for any locality was often ignored.

However, most, if not all, the early drainage work carried on in that portion of Missouri proved satisfactory to the landowners, as the value of the land was increased many times the amount assessed against it to pay cost of drainage.

The area improved by such work approaches, if it does not reach, the half million-acre mark, and swamps, which had produced nothing better than the deadly malaria-carrying mosquito, were transformed years ago into fertile fields that now command high prices, providing happy homes for tens of thousands of people and food for millions.

Although the work prosecuted in the foregoing described manner resulted in the complete reclamation of a vast territory, much of the land included in the pioneer drainage districts was only partially relieved from water troubles, and it has remained for the expert, usually developed from the pioneer engineers who knew little or nothing at first about scientific matters, to solve the difficult problems whereby the

complete reclamation of a large per cent of all the lands in the districts can be accomplished.

The whole matter may be summed up briefly by stating that land drainage in Southeast Missouri, although desultory, proved a paying business in the pioneer stage or from the start, but it has been made more effectual and remunerative by experience and application of scientific knowledge.

The early drainage work done along the small streams of this State, where the valleys range from one to three miles in width, has not resulted in as great degree of success as the pioneer work in Southeast Missouri. A number of drainage districts in these narrow valleys have been visited by the writer in the last year and thorough examinations made to ascertain the actual conditions and the causes of success or failure in such districts.

In some localities, where the drainage systems have been in existence for sufficient time to test their efficiency, it was admitted, by even persons who had urged the organization of the districts and were enthusiastic at first over the systems adopted, that they were disappointed and that there were no prospects of much, if any, improvement in conditions without the expenditure of more money to put into effect additional ditches and levees. While land values in such districts have advanced, these were not due always to the improved conditions brought about by the systems of drainage in force. The drainage tax against the land yet unpaid is a burden which investors shun, and many owners are not receiving sufficient additional income from their land to more than pay the annual assessments.

In other districts conditions were better, but not what the landowners had expected of the work when the districts were formed. Some lands have been considerably improved by the work while other lands in the districts seemed as wet and untillable as they were before the ditches were dug.

A study of the different systems in operation and a comparison of the results of the same enabled us to reach conclusions that may prove helpful to persons planning to drain lands similarly located and of like character.

The least benefits have been derived from ditches constructed near where the old channels were situated. Such work has wrought but little benefit in many places. Where considerable sections of ditches have been constructed through wide valleys and the waters afforded an opportunity to flow independently through both the old and new channels, the lands at the upper portions of such localities have been relieved from overflows at ordinary flood periods. Furthermore, the waters that

accumulate in the low places, through which such new channels pass, run into the new channels within a reasonable period, and the lands are also afforded partial underdrainage of the excessive waters taken up by the soil.

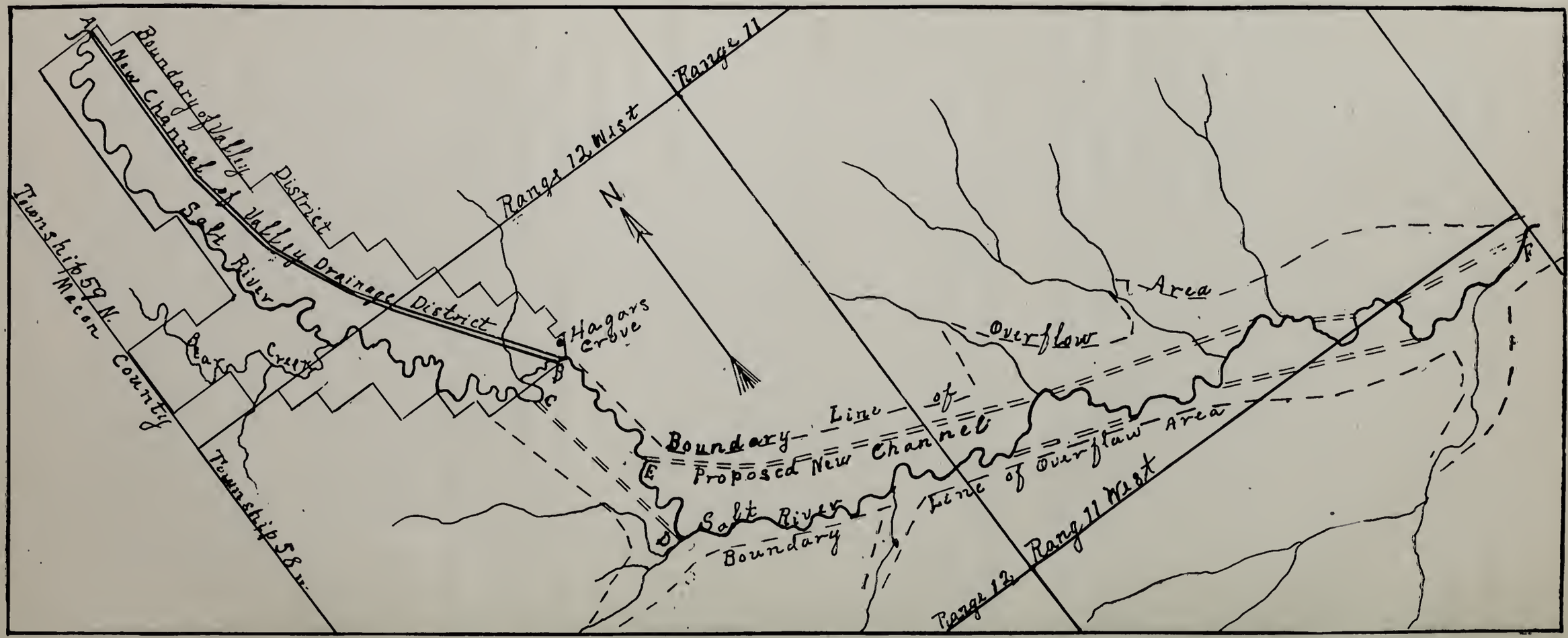
But this relief for a portion of the land is only "robbing Peter to pay Paul," for, while the old and new channels, working together, prevent the flooding of the lands at the upper parts of these localities, the waters of the two meet where the channels come together, causing the lands for some distance above and far below to be flooded. The sections of the original channels below these points that have been depended upon to carry the combined waters of the new and old channels, having only the capacity of the old, are unable to perform this task; as a result, the currents of the two channels are retarded for some distances above their meeting places.

Usually the currents are light in short sections of new channels, and sediment is often deposited therein during each flood period, until some ditches have been filled up greatly. This condition exists especially where the bottoms of the upper ends of the ditches were not dug to a level of the bottoms of the old streams.

One of the erroneous ideas that seems to have prevailed in most localities was the supposition that drainage ditches would rapidly wash deeper; acting upon this theory, new channels were rarely constructed more than two-thirds the depths of the old. Landowners who have followed this method have been greatly disappointed. It is admitted now by all who have had experience that the bottoms of new channels at the starting points should be dug level with the bottoms of the old streams, unless the depths of the latter be so great as to render the cost of construction unreasonable. Damming the old streams slightly, in order to force the water through the new, has been resorted to in some districts, but this is a hazardous method, as there is grave danger of drafts forming above such dams and thereby choking the mouths of the ditches and forcing the waters at ordinary rain periods out over the adjacent lands.

A method for obtaining relief from water troubles for the lands in the valleys of small streams is illuustrated by the map on the following page. It has been presented to and approved by a number of experts in land drainage. The first six miles of the map represents the system of drainage adopted by the Valley Drainage District of Shelby county, Missouri, which the writer helped survey and plan. The ditch A B, about six miles long, is now being dug, and landowners below the end of this district are planning to extend the work down the valley some eight miles to where the overflow area narrows.

It will be seen that the first section of the ditch taps the old channel



Map of Valley Drainage District of Shelby county, Missouri, indicating plans being put into operation and suggestions for extension of the work down Salt river to where the overflow land narrows. A full description of these plans will be found in this division of the report.

at point A, runs down the valley to point B, where it meets the old channel, and is located as closely as practicable to one side of the overflowed territory, where the lowest land exists.

The waters of the new channel must be emptied into the natural channel at B, as the high land and the channel meet near there. Unless some relief is supplied the waters of the two streams meeting at this point will flood the land at and below, so provision must be made to prevent such an occurrence.

This can be accomplished by beginning a second section of the new channel at point C, which is close to the high land on the opposite side of the valley, and continuing the same downstream through the lowland of the wide bottom to point D, where this section must be emptied into the old channel, which has returned to that side of the valley. The same congestion and overflow will occur here as was described at B, unless something is done to prevent it; for that purpose a third section of the new channel must extend from point E to point F, where the hills approach to within a few rods of each other, and where the district must necessarily end. When completed the valley will have two channels, A B E F and A C D F, working almost independently but conjunctively. Although the sections of the new channel may have less width than the old they will be equal in depth, and because the fall of the new sections is much greater their currents will be much swifter than the current of the natural stream.

Such a system possesses the following advantages: There will be no congestion of waters and overflowing of the lands where the sections of the new channel meet the old; all the lands in the valley will be afforded practically the same relief; the flow of the water will not be retarded where the new and old channels meet; two streams will be working instead of one; the "troughs" in the wide bottoms, where the surface of the land is lower than the banks of the old channel, will be opened up and the waters allowed to flow out; partial underdrainage will be provided for the lands.

A system very similar to the one described is now being put into operation along the Marias des Cygnes river in Bates county, and the results of these two districts will be watched closely by all interested in land drainage, especially along small streams. A description of the Bates county district, accompanied by a map of the same, will be found in another part of this report.

It must not be supposed from the foregoing statement and suggestion of plan for a drainage district that any fixed method or plan can be drawn for successful application to all overflowed areas in Missouri. Local conditions in a valley usually govern the plans that must be ap-

propriated for reclaiming the lands, and often it is difficult for experienced engineers and landowners to decide just what system will prove most beneficial. It is believed, however, that systems modeled after the one herein described can be applied successfully to most districts.

The costs of such systems will no doubt exceed the costs of others that might be outlined, but their increased efficiency will be worth the additional expenditure of money.

In some localities where the valleys are wide it is possible to plan levee districts at the outset to give protection at once to most of the territory, but so far no such scheme has been tried in Missouri. Drainage systems for the land along the small streams should be outlined with a view of rendering it possible later to surround most of the land with levees. Drainage ditches or new channels should be located with this end in view.

It is absolutely impossible to prevent the overflowing of lands in the small river bottoms at all times by constructing new channels. Excessive rainfalls that occur from time to time fill the whole valleys with water and convert the same into running streams. The best that can be done for such lands is to prevent the ordinary overflows and provide for the removal of the waters as rapidly as possible after each flood.

The lands along the sides of these valleys are usually considerably elevated, and the small streams which drain the same have enormous slopes that rush the waters rapidly into the valleys after each heavy rain, causing flashy rises in the rivers and the lowlands to be submerged. The hill lands are limited in capacity to absorb and power to retain water, as the soil is not deep and usually has a compact subsoil, conditions that are exceedingly detrimental to the valley lands.

Many persons contend that cutting off the large bends in the old channels, which work reduces their lengths, will cause much greater volumes of water to flow through them within a certain period. Such work has been found beneficial, but it does not furnish a very large degree of relief. The flow of water through channels will be augmented somewhat by such work, but it affords only slight additional opportunity for water to flow out of the wide low bottoms, and it supplies no underdrainage.

It is contended by some that the rate of current in a new channel one-third the length of the old, owing to the excess slant of the former, will be three times the rate of the current in the latter. This is not true by any means. Investigation has proven that the rates of currents in streams are approximately to each other as the square roots of their declines, other conditions being equal.

The fall of two channels between given points in a valley are to

each other as their lengths. Therefore, the rate of current in a new channel one-third the length of the old, under the foregoing rule, would be to the rate of current in the old stream as 7 to 4, were all other conditions uniform.

However, the rate of current in an artificial channel will be greater than the current in a natural channel, attributable to the straight course the water has to travel, the absence of irregularities in the banks and bottom of the new channel, and lack of drifts to obstruct its flow.

The amount of water that passes through a channel depends entirely upon the rate of current and is not influenced by the distance the water has to go. If the cross-section of a new channel for a drainage district be equal to the cross-section of the old channel, and the former has a current of six miles per hour while the latter has a four-mile current, the new channel will discharge just fifty per cent more water during a given period than the latter will discharge.

To illustrate the point, suppose the reader were standing on the land between the above two channels where they converge, and that each had a capacity of one hundred thousand cubic yards of water per mile; the water that is now six miles up the new channel and the water four miles up the old channel from him will pass him one hour from now, demonstrating that the new channel will empty six miles of its length and the old four every hour. Putting it in another form, six hundred thousand cubic yards will pass him through the new channel and four hundred thousand through the old in one hour.

In his address before the Drainage and Levee Conference, held at Jefferson City, Mo., on October 18th and 19th last, Mr. Otto Kochtitzky, a civil engineer of Cape Girardeau, Mo., who has devoted many years to land reclamation and has made careful study of all phases of the subject, speaking on the protection of narrow creek and river valleys from overflows, said:

"The straight channel affords a shorter distance to the outlet, but does not give much greater capacity of flow. This would only be obtained by also enlarging the old channel—an enlargement of sufficient size to handle the floods is beyond a reasonable cost, as will be readily seen by computing the quantities of the floods to be handled.

"My observation of Castor and Whitewater river floods compared to channel capacity showed several flood movements in the valley to be at least four times the capacity of the channel within banks.

"Hence the overflow will occur, and it would seem that a better promise of results commensurate with cost would be obtained through the plan of reclaiming sections of the valley favorably located by separate levee districts, as described in the plan recommended for the Marias

des Cynges river valley in Kansas, leaving ample waterway between the levee districts to accommodate river floods.''

The foregoing discussion is not intended to discourage owners of swamp lands who contemplate the reclamation of their possessions. The purpose of this article is to point as a warning to others the mistakes that have been made in a few localities, and to offer certain suggestions for use hereafter in drainage work. There are very few areas of overflowed or swamp lands in Missouri that cannot be improved by applying some schemes of drainage and whose values can not be increased many times the costs of such systems. The important matter always to be considered is what plan will prove to be the most beneficial after having been put in force.

The heaviest wheat in the field is always found on the reclaimed portion of land.

RECENT FLOODS IN MISSOURI AND LOSSES THEREFROM.

Missouri has experienced some disastrous floods during the last third of a century that have wrought great havoc. The floods of 1882, 1883 and 1884 were exceptional in that they came in succeeding years and were of unusual heights. No definite data of these floods except that shown by the government gages were recorded and their destruction to property cannot be estimated.

The following extreme stages above flood gage (13 feet) of the Mississippi river were recorded at Hannibal, Missouri, during the previous twenty years:

Year.	Month and day.	Stage of river.
1892	July 3	20.8 feet
1897	April 29	20.8 "
1903	June 8	22.5 "
1905	June 12	18.3 "
1908	June 1	17.6 "
1912	April 8	18.0 "

The flood of 1903 was extraordinary because the waters not only reached high stages but the rises came in the Mississippi and Missouri rivers about the same time—during the last of May and the first of June above St. Louis, and from ten days to two weeks later below that city. These waters were very disastrous to all classes of property in the valleys of both streams. They covered all the bottom lands in this State along the Missouri river from the Iowa line to Kansas City, thence to the river's mouth. The Mississippi flood covered all the Missouri lowlands from Keokuk to St. Louis, and the combined waters of the two rivers caused a general flood in the Mississippi south of St. Louis.

The wheat in these valleys was destroyed and fences, railroads and other property were washed away. Many flooded fields could not be cultivated that year because the waters did not recede until the middle of June. No effort was ever made to compile data showing the values of Missouri crops and property destroyed that year, but the total must have been around fifteen million dollars.

The 1908 high waters caused very great destruction to crops in the north half of Missouri. Close to a million acres of corn, wheat and other crops in Missouri, worth at least $15,000,000, were swept away about the first of July. Much of the wheat had been harvested and was in the

shock; very little of it had been threshed, and all of it went with the deluge. The corn was almost ready to tassel and gave promise of making a tremendous yield, but it went as did the wheat.

The most ruinous flood to all classes of property that has ever occurred in the north half of Missouri, especially along the small streams, was that of July, 1909. Excessive rains, amounting to as much as six and eight inches in some parts, fell over that portion of the State drained by the Missouri river and its tributaries and the Mississippi and its auxiliaries north of St. Louis. Regular cloud-bursts occurred, and the waters that fell on the hills along the small streams rushed into the valleys, causing liquid rolls varying from three to five feet deep to go tumbling and rumbling down the valleys at a terrific rate and with irresistible force, sweeping before them everything they met and destroying crops, live stock, farm improvements, railroad and all other property.

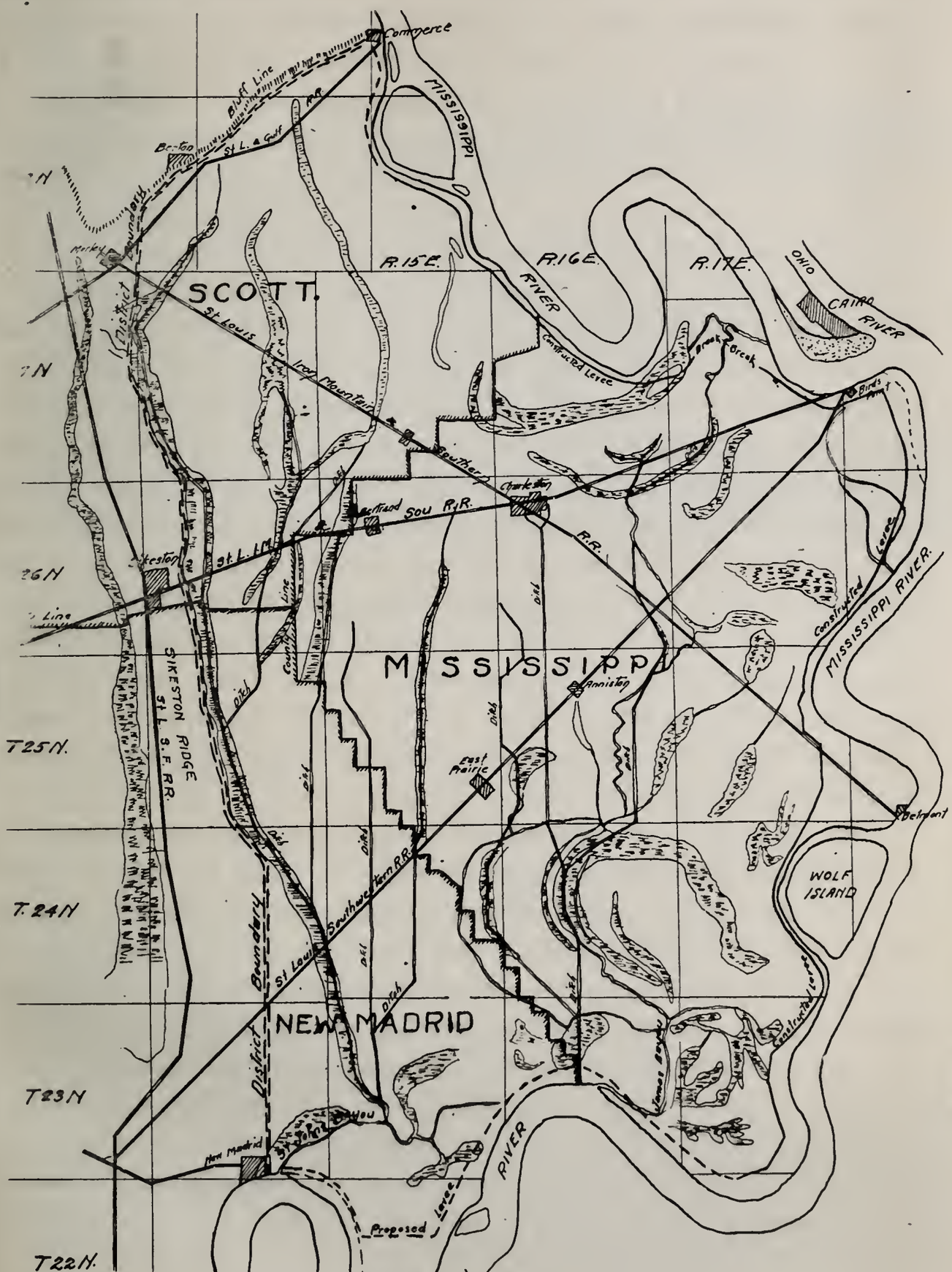
These valleys were transformed within a short time into rivers from one to three miles wide, with water flowing down them at the rate of three or four miles an hour, and they continued in this condition for a number of days or until about the middle of July. The losses in some counties ran up as high as one and one-half million dollars, while in many it went above the half million-dollar mark. The total destruction to crops and injury to property from this flood was estimated at $21,000,000. The 1908 and 1909 floods, coming as they did in the middle of the years, made it impossible for farmers to raise crops either year on the overflowed areas. The 1903 flood came and retired in time for farmers to plant and cultivate considerable crops on the land that was flooded.

The 1903, 1908 and 1909 floods and the losses caused by them having been dealt with extensively in a report prepared by the writer two years ago, discussion here of these three floods is unnecessary now, as the same would be a repetition of what was said in his former narration.

There were no floods of any consequence in either 1910 or 1911, except along a few minor Missouri streams, caused by heavy local rains at various times.

The Missouri river did not reach a high stage at any time in 1912, only the fields of wheat in the low bottoms being destroyed. The waters receded in ample time for such fields to be planted into corn and other crops this year. The flood of 1912 which was general in the Mississippi river along the east side of Missouri, resulted in great damage to various classes of property.

Considerable damage was done in the lower part of Clark county by this flood. The heavy ice that had been created in the river during



The above map indicates the lowland in the eastern parts of Scott, Mississippi and New Madrid counties, Missouri, covered by the 1912 flood. The levee spoken of in the accompanying article is represented by the continuous line along the Mississippi river and the proposed extensions by broken lines.

Sentiment prevails in favor of making this levee solid from Commerce to New Madrid, leaving an opening at the latter place for water that falls in the district to drain out through St. John's bayou with a levee on each side some distance to prevent floods from spreading out over the territory. This plan has been endorsed by the Mississippi River Commission, and there is every reason to believe the Federal Government will pay for building an absolutely safe levee the entire distance, provided landowners agree to build the necessary internal ditches and other improvements.

passed through the crevasses in the levees opposite Cairo flowed on south through the St. John's Basin, some of it joining the Mississippi's main channel at New Madrid, while the remaining portion went across the low places in Sikeston Ridge into the Little river country and continued its course south through the St. Francis River Basin.

The following table of gages above flood stage, made up from the records of the Mississippi River Commission, furnishes a comparison of the 1912 flood with others that have occurred in Southeast Missouri within the last thirty years:

Yr.	Day and month.	Maximum stage.	Ft. above flood stage.
1882	February 26	51.87	6.87
1883	February 27	52.20	7.20
1884	February 22	51.79	6.79
1892	April 28	48.29	3.29
1897	March 25	51.67	6.67
1898	April 6	49.78	4.78
1903	March 15	50.60	5.60
1907	January 27	50.30	5.30
1908	April 19	45.55	.55
1912	April 6	54.00	9.00

The waters remained above the 45-foot mark, which is flood stage at Cairo, for more than fifty days altogether, thereby surpassing all other duration records, and its highest gage was two feet above the top of the levee as it stood before being washed away.

It will be observed the high record of 54 feet was reached on April 6, or about one week after the two gaps were washed in the levee on the Missouri side which allowed the waters to flow through the Missouri low country. Levees in Kentucky and Tennessee gave way earlier and permitted the waters to spread out and flow through an extensive area on the east side of the Mississippi's regular channel. Had the levees on each side been of sufficient altitude and strength to have held the waters between them, the flood would have been forced to a much higher stage than was recorded.

These are important facts to be kept in mind by the engineers and landowners who undertake to construct levees that will protect the Missouri lands from overflows at all times hereafter. As stated in a previous paragraph, the flood plain reached two feet above the levee top. If the same volume of water is to be confined hereafter between levees on both sides of the river within the vicinity of Cairo, the Missouri levees must have an altitude equal to a sixty-foot stage of the river, and probably more will be required. This matter has been treated at length under another head, "Adequacy of Levees Made of Alluvial Soil."

The flood waters of the Mississippi formerly, when obstructed by meeting the Ohio waters at Cairo, found an outlet through the lowlands

between Cape Girardeau and the elevated land beginning at Grays Point, passing into the Little River Basin, thence on through the St. Francis river and back into the Mississippi at Helena, Ark. This acted as a safety valve originally and furnished an outlet to a large volume of water during the flood periods, and assisted in keeping the Cairo stage below what it would have reached without such a vent.

This outlet has lately been closed by a levee being built across it to prevent the Mississippi waters from entering and overflowing the Little River country, and evidently it will result in forcing the waters higher at Cairo and other points nearby.

The Southeast Missouri territory submerged by this flood amounted to about 700,000 acres, situated principally in Mississippi, New Madrid, Scott and Pemiscot counties, of which not more than 125,000 were in cultivation. While the floods were raging and for many weeks after the waters had subsided the citizens, being in dire distress and under great excitement, were led to overestimate the results of the disaster that had befallen their country. The computations of total losses varied from three to fourteen million dollars. The former is probably too low but the latter is no doubt beyond reason. The growing crops, such as wheat and alfalfa, destroyed were worth around $2,000,000, and the damage to farm improvements amounted to $250,000. Live stock worth $100,000 were drowned and railroad property of all kinds suffered $500,000. It will require $145,000 to restore the levees to their original condition. These items total almost $3,000,000. To these should be added the decline in the various classes of business, especially in the towns, where trade was paralyzed for weeks. It is conservative to say the actual loss did not go above $5,000,000, and it probably fell considerably short of that sum.

It has been estimated by the Mississippi River Commission which has charge of the repair work on the Southeast Missouri levees, that it will cost $130,000 to close the crevasses caused by the 1912 flood, and that $14,000 will repair all other damages sustained. Congress has already appropriated $250,000 to be expended for this work on these levees and otherwise strengthening the same. This will lift the burden from the shoulders of the landowners, make the levees stronger than ever before and thereby enhance the values of the lands.

Some persons claim the values of lands overflowed have been greatly affected by reason of this flood and they have endeavored to compute such losses. The land itself did not suffer, neither is it believed prices at this time—eight months after the waters passed away—are lower than they were one year ago.

Many citizens claim this flood will prove a blessing in disguise to

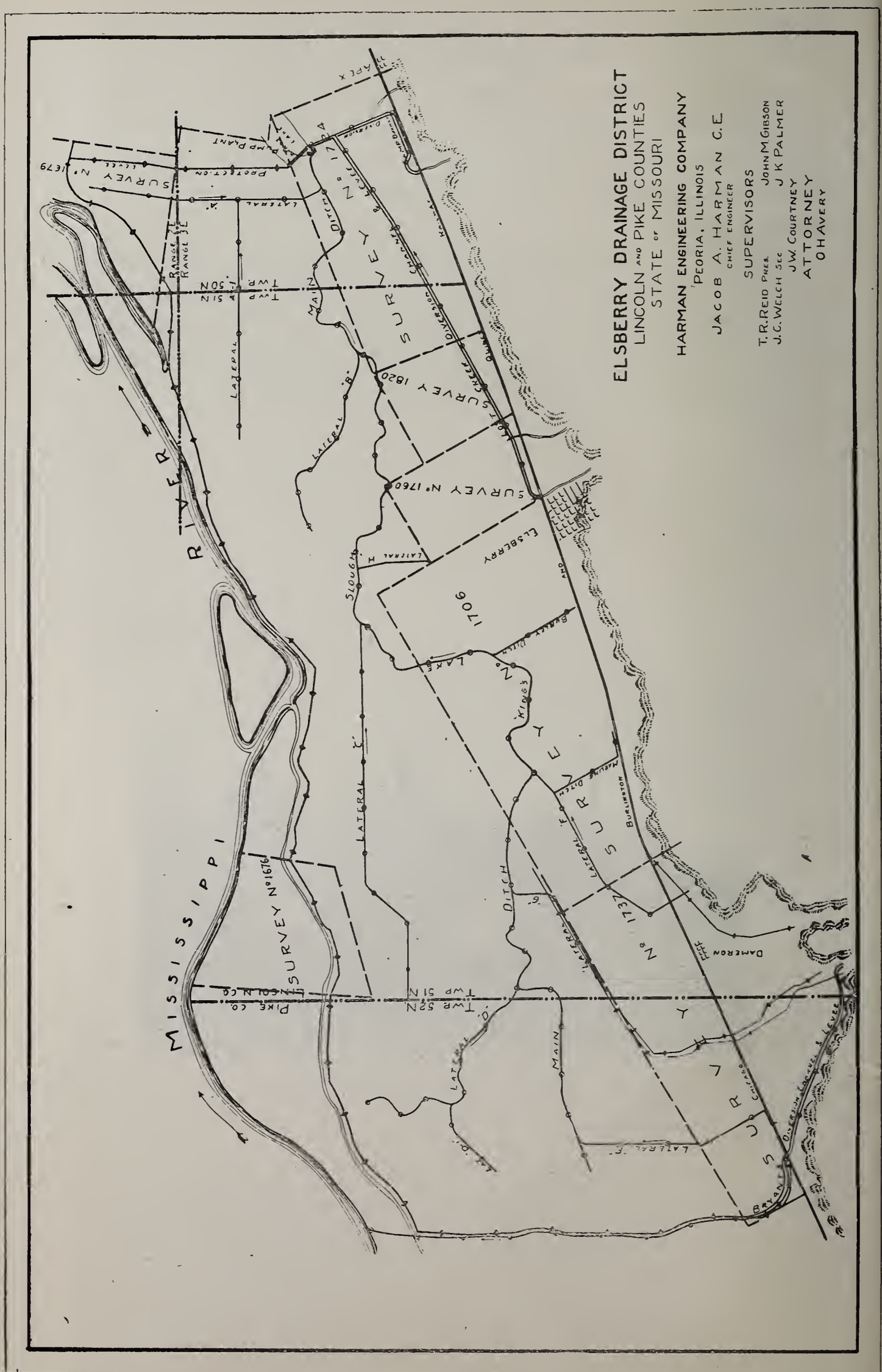
A levee reenforced by the use of sacks of sand. Often the height of a levee is increased two or three feet and the structure made to hold by placing sacks of sand on it.

Loading sacks of sand on cars to be transported to weak places in levee. All classes of people—the farmers, merchants, ministers, "wets" and "drys"—worked side by side for days trying to save the levees.

Southeast Missouri, as it will be the cause of the levee now extending from Commerce in Scott county to Dorena in Mississippi county being continued on to meet the Pemiscot county levee at Point Pleasant, and the whole will be elevated so its crown will be a number of feet above all future flood planes. The width and strength of such a levee will be ample to withstand all pressure and furnish absolute security for all time to come.

It will not only protect the 125,000 acres that have been cultivated heretofore and increase their values, but it will induce the owners of the remaining 575,000 acres to drain the swamps and bring all of this land under cultivation. Such improvements will increase the present prices which now range from $15 to $25 per acre to $100 per acre.

Farmers who cultivate reclaimed land dress well, appear well and are happy.


ELSBERRY DRAINAGE DISTRICT
LINCOLN AND PIKE COUNTIES
STATE OF MISSOURI
HARMAN ENGINEERING COMPANY
PEORIA, ILLINOIS
JACOB A. HARMAN C.E
CHIEF ENGINEER
SUPERVISORS
T. R. REID PRES. JOHN M GIBSON
J.C. WELCH SEC J K PALMER
J.W. COURTNEY
ATTORNEY
O H AVERY
MISSISSIPPI RIVER
SURVEY N° 1679
SURVEY N° 1760
SURVEY 1820
SURVEY N° 1706
SURVEY N° 1737
SURVEY N° 1676
ELSBERRY
LATERAL
MAIN DITCH
SLOUGH
LAKE
TWP 52N
TWP 51N
RANGE 3E
RANGE 4E
PIKE CO
LINCOLN CO
BURLINGTON
CHICAGO
DAMERON
BRYANT

MISSOURI'S DRAINAGE AND LEVEE LAWS.

The Missouri drainage and levee laws, as contained in chapter 41, Revised Statutes of 1909, with the amendments adopted by the 1911 Legislature, have been found adequate in general for the organization and administration of drainage and levee districts. The general provisions of the Missouri statutes are being used as models for the preparation of drainage and levee laws in other states, and the Federal Department of Agriculture, Washington, D. C., has recommended our system of laws for that purpose.

The Supreme Court of this State, in its numerous opinions rendered within the last few years relative to these laws, has universally upheld their constitutionality, and wherever the drainage districts have adhered to the provisions of the statutes their acts have been affirmed.

While all this can be said in favor of our drainage and levee laws, they are yet in need of many amendments and changes that will render them more effective, simplify their use and clarify their meaning. No surprise should be occasioned by this statement, and neither can it be construed as contradicting what has been said in favor of our laws in the previous paragraphs. These laws, like the laws of this State relating to any other subject, have gone through a process of evolution, with the unnecessary portions being eliminated at each session of the Legislature and additional amendments and changes adopted to improve them. The laws governing our schools, road building and many other important matters have undergone biennial changes regularly ever since lawmaking began in this State, almost a century ago; yet they are now far from being perfect, if the numerous bills relating to these laws presented and urged for passage at each meeting of the Legislature form any grounds for drawing a conclusion.

If legislators have been unable to perfect those laws during so long a period, there is no reason why they should have been expected to have completed in every way the drainage and levee laws, whose beginnings date back only a few years. Our present drainage and levee laws contain a larger per cent of the most important rules necessary to successfully organize and administer the affairs of districts, but these are thrown together in such a haphazard manner as to cause confusion in many instances. It becomes a tedious and irksome task to pick out the various provisions of these laws and know just when and where to apply

them in the organization of a district. This defect is due principally to the Legislatures of the past having added various and numerous amendments to existing sections, instead of having set out such provisions in separate sections. No other laws seem to have been amended so frequently in this manner.

Section 5513 of the 1909 Revised Statutes illustrates this point very vividly. This section sets out to define the powers of boards of supervisors of drainage districts, but digresses shortly and describes how all bridges shall be built. It then returns to the question of the boards' powers, but breaks away again to define the method of obtaining property for use of districts. Following this, it takes up the matter of increasing the heights of railroad and other embankments, then specifies under what conditions or when districts shall be entitled to enter upon any lands condemned for use of the districts, and winds up by stating how payment shall be made for such lands.

This section covers two and one-half pages of the statutes and contains at least half a dozen different provisions, all of which are important and ought to be retained, but which should be set out in as many separate sections.

It is doubtful if any other section in the entire statutes of Missouri contains as many important rules that are so improperly and confusingly arranged.

The present condition of our drainage and levee laws has not only proved a puzzle to attorneys and the lower courts of Missouri, but has confounded even the members of our Supreme Court, who have failed to agree as to the meaning of certain important provisions that are wound around each other so frequently in these statutes. It is a well-known fact that certain members of this distinguished tribunal share in the opinion that these laws should be amended, rearranged and thereby clarified immediately.

The land reclamation movement in Missouri just now is suffering from an overabundance of drainage and levee laws. There are five separate and distinct laws whereby drainage and levee districts may be organized in the county courts in this State, and two other laws giving power to incorporate districts in the circuit courts. This multiplicity of methods has been found confusing, not only to landowners in many communities, but to some of the best attorneys of this State. It is almost universally agreed by persons acquainted with the various laws that the number of methods should be greatly reduced, and that the same can be brought about without in any way detracting from the present provisions of the statutes or disturbing the districts already organized and operating under them.

This can be accomplished by combining all the important and necessary provisions now contained in article I (the circuit court drainage law) with article IX (the circuit court levee law) of chapter 41, Revised Statutes of 1909, as amended in 1911. The same should be done with the provisions of articles III and IV (the county court drainage laws) and X (the county court levee law) of the same chapter. Such laws can be drawn so as to give to them the combined strength of our present statutes plus any important additions that might be considered necessary.

No more argument can be produced in favor of the State supplying triple, quadruple or even sextuple sets of laws for the organization of drainage or levee districts than can be produced in favor of its maintaining the same number of different systems for the regulation of the public schools, road building or the organization and control of other corporations other than drainage and levee districts. Dual systems, one providing for organizing districts by the county courts and another incorporating districts in the circuit courts, have been pronounced sufficient by many persons for all purposes.

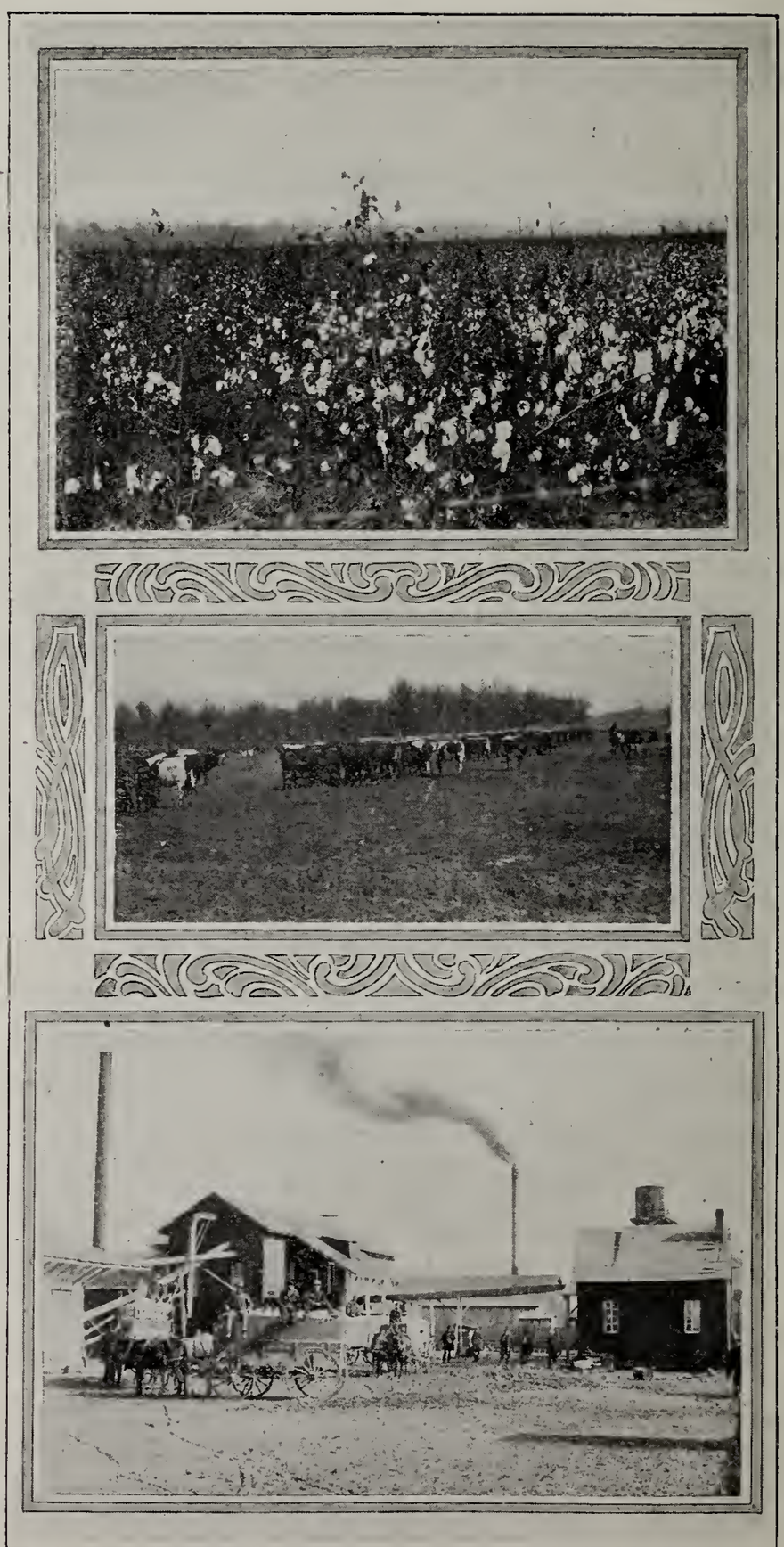
The circuit court drainage and levee laws of Missouri contain certain admirable provisions and advantages which the county court laws do not possess. The county court laws, however, have been found to be more expeditious and economical, and, therefore, are more desired by many persons than the circuit court laws.

The circuit court laws delegate all of the important work of devising plans for reclaiming the lands, deciding the amounts that shall be expended on the projects, employing engineers, attorneys and other help, and administering the affairs of the districts entirely to the boards of supervisors, who must own land in the districts and who are elected by the landowners. The county court laws give the county courts the exclusive power to appoint all officers, including the commissioners, who must not be landowners in the district, and who formulate plans of reclamation, decide where the ditches and levees shall be located and determine the amounts of money that shall be expended.

The circuit court laws place all the grave matters in the hands of the landowners, who must pay the bills, while the county court laws turn the business over to entirely disinterested persons.

There seems to be no valid reason why a set of rules adopted for organizing drainage districts should not be suitable for organizing levee districts as well. The works constructed in the two usually correspond, the court procedure is the same and the administration of the affairs are identical.

Realizing the necessity and importance of securing uniform, simplified and more effective drainage and levee laws for the various states



Missouri's drainage and levee laws have enabled Dunklin county landowners to transform swamps into the heaviest cotton-yielding fields in America, provided splendid pastures and resulted in cotton gins being established at many points.

having swamp and overflow lands within their borders, the National Drainage Congress, which has for its aims and purpose the reclamation of all such lands in the United States, at its meeting held in Chicago, Ill., December 8 and 9, 1911, adopted a resolution urging the legislatures of these states to pass such laws. In order to encourage and assist these legislatures in carrying out the spirit of this resolution, the executive officers of the Drainage Congress called a meeting of all persons interested in this matter at Memphis, Tenn., January 21, 1912. Nine states were represented at this conference and the outlines for a model uniform drainage and levee law were formulated. A committee was appointed to finish the work before the conference adjourned.

The bill as finally drafted was reported to the National Drainage Congress at its meeting in New Orleans in April, 1912, and the work of the committee approved. One state has already adopted a modified form of this measure, and legislators of other states are preparing similar bills to be introduced at the coming sessions of their Legislatures.

This model uniform law is based principally upon article I of chapter 41, Revised Statutes of Missouri, 1909, as amended in 1911. The existing general provisions of that statute were retained and a few important amendments inserted.

All ambigious sentences were rearranged so as to clarify their meaning and eliminate uncertainties; seemingly conflicting sections were changed to exclude contradictions, and the unnecessary repetitions that occur so frequently now in that law were stricken out.

The long sections which deal with two or more separate and distinct subjects and contain an equal number of unlike provisions were divided into separate sections, each relating to only one subject. The sections were then arranged in the order in which the various steps must be taken to organize and administer the affairs of a drainage or levee district.

The sections that define certain terms, powers, duties and court procedures come next in order, and those conferring additional or discretionary powers upon either the court, landowners or officers of the district were placed last.

The sections as thus arranged were divided into four groups, namely: "Organizational," "Administrational," "Definitional" and "Discretional." This classification will surely meet the sanction of every one who has occasion to use the law. The plan has been commended by many persons who have studied it.

The bill enables the landowners to organize either drainage or levee districts, depending upon which is needed in the various localities.

The same method can be followed in formulating a law to take the

place of the various county court drainage and levee laws now on the statute books of Missouri. Such a law would prove more satisfactory to all who have occasion to use it in forming districts, just as it is believed the model, uniform law drafted by the committee representing the National Drainage Congress will be found more satisfactory than the present Missouri circuit court drainage law.

Wheat field on drained land.

ADEQUACY OF LEVEES MADE OF ALLUVIAL SOIL.

Fear existed until recently in many minds that levees constructed out of Missouri alluvial soil would not possess the necessary cohesive power to endure the lashing waves and eroding currents, or strength to withstand the waters' enormous pressure during the floods periods, and this misgiving remains yet in the minds of some persons.

Such apprehension can usually be traced to the pioneer levees failing to meet the landowners' expectations, which, however, were often set at too high mark. These failures were due generally to defective judgment of the man who planned them, or to faulty contruction. Artificial embankments for land protection are human products and when properly constructed will afford substantial protection, and the men who hereafter design and build them will be held responsible if such works do not render proper service. The men to whom was assigned the task of building the early levees probably did the best they could, considering the small sums set apart for their use and their limited knowledge of such employment. The work being experimental, the landowners were unwilling to invest heavily in these untried and uncertain enterprises.

Most of the first levees built in this country were deficient in both altitude and magnitude. Their tops were usually a number of feet below previous flood planes established even while the waters were permitted to spread out over and flow through the wide bottoms. This insufficiency in elevation permitted them to be topped by the waters frequently and some were washed away about as often as the floods came.

Many of them were built without due consideration of the side slopes. The earth was piled up as straight as possible by the use of teams and scrapers, and logs, stumps and any other materials that would increase the volume of the embankments were covered up at the places where they lay. Often such substances were hauled to and made a part of the edifices. These substances decayed within a few years leaving soft places which weakened the levees, and which too often were not discovered until breaks had occurred and the waters came rushing in upon the farms.

Proper foundations for levees received but little or no consideration, and the engineering feature of this work was considered a minor matter,

as the landowners usually formulated the plans and superintended the construction.

Such levees were obtained cheaply and the services they rendered were on a par with their costs. It required years of constant rebuilding the crevasses that so frequently occurred, strengthening weak places, increasing their cross sections and solidifying the holes and inside vacant places due to the decaying timbers embodied in them, to make the land behind such levees safe. Landowners have learned by experience, which, by the way, has proven a costly teacher, how to construct levees that will keep back all stages of the rivers so far recorded.

Missouri levees that have been in existence for a number of years furnish convincing proof that alluvial soil will make tenacious, strong and durable structures when properly erected. Discussing this question in a report issued three years ago, the writer pointed out various Mis-

Levee Building in Missouri.

souri levees that had been in use for some years and that had been tested by a number of floods. Among such levees are those of the Kings Lake and Cap Au Gris Levee Districts in Lincoln county; the South River Levee District in Marion county and the Des Moines and Mississippi Levee District in Clark county. A heavy Mississippi flood occurred in the spring of 1912, that put each of these four levees through an additional ordeal, but it found neither wanting. The waters reached within a short distance of the tops of one or more of the four but not a single break occurred, and at no time was the land surrounded by them in danger.

The Southeast Missouri levees along the Mississippi river on the east side of the Saint Francis Basin underwent the most severe test by the flood of March and April this year they every experienced. Although

Patrolling a levee during the flood.

two crevasses occurred in the levee in Missouri opposite Cairo, Illinois, they were not "breaks," caused by the levee giving way under the waters' heavy pressure, but gaps washed in the embankment by the waters rising above and pouring over its crown. This levee had been built with a view of its resisting only a fifty-foot stage of the waters at Cairo; its top was even with a fifty-two foot gage and it stood firm until the waters reached that point.

(An extensive account of the 1912 flood in Southeast Missouri and its effects on levees, crops, farms and other property will be found in this report under the head "Some Missouri Floods and the Losses Therefrom," to which readers are referred.)

The waters later rose to a fifty-four foot stage, which was two feet above the levee, and many miles of it were completely covered by flowing waters during a number of days. The levee emerged from this crucial test with scarcely a blemish or even a scar, outside of the two crevasses heretofore mentioned, which, as has already been pointed out, were the results of waters pouring over the top in cataract manner for many hours.

The levee extending from Point Pleasant in New Madrid county into Arkansas that has been in use for almost a score of years, proved equal to the occasion this year. The river bank that forms the base for a small portion of this levee near the upper end washed away, allowing the levee to cave into the river. This incident was not due to insufficiency of strength or altitude.

The main portion of this levee lying south of Portage Bay, although deficient in height at places stood firm. The landowners kept constant vigilance over its entire length for sand boils, caving sections and other danger signals, and by the use of sacks of sand and earth increased its altitude wherever needed. The levee between the city of Cape Girardeau and the elevated land a few miles down the Mississippi river was another that stood out against the 1912 flood.

These two levees by passing successfully through this test, which lasted for almost a month, added their testimony to the suitableness of Missouri alluvial soil for levee construction.

Having shown by these citations that levees built of Missouri alluvial soil are durable and strong, and that they can be made to furnish safe protection for land, the question may be asked, why have levees failed in many instances and allowed the lands to be overflowed? The answer to this question has been intimated in the early part of this article where the defects of the pioneer levees were pointed out.

The essential qualifications of a successful levee are proper altitude, magnitude, width of crown, width of foundation and composition,

neither of which can be dispensed with or should be disregarded in levee building.

The altitudes of levees built for absolute safety hereafter must range from four to ten feet above the highest recorded stages of the rivers, and in some localities probably greater than ten feet will be required. Levees are built for the one purpose of confining the flood waters in a much less space than they have been accustomed to utilize, and such limitations will force the waters to obtain outlets through higher planes than were required so long as the same were permitted to pursue their original habits of utilizing all the low lands for flowing purposes. Missouri landowners are not alone in this great land reclamation movement, for the farmers of Illinois along the east side of the Mississippi river have led us in levee building, and our neighbors across that river in Kentucky and Tennessee have lined this stream with levees equal in every respect to the Missouri levees most of the way from Cairo, Illinois, to Memphis, Tennessee.

The same excessive volumes of water are sure to come down the various rivers hereafter that have been witnessed in the past, and landowners must arrange to care for such floods. Such preparation will depend more upon the levees being furnished that quality of altitude mentioned in the previous paragraph than upon any other attribute.

The strength of levees depends principally upon the widths of their bottoms, which are governed chiefly by the slopes of the sides, and vice versa, the two usually being spoken of in the ratio they bear to each other. When the elevation of a levee is equal to one-half that portion of the base situated directly under the slope of the side, it is said to have a 1 over 2 slope. This form of slope is illustrated by Figure 1 accompanying this article in which line FE is twice the length of line DE. A levee

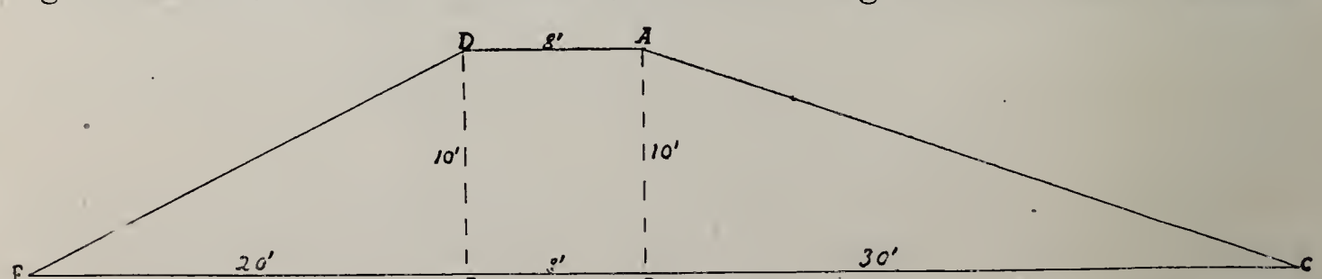


Fig 1 indicates levee with left side 1 over 2 and right 1 over 3, crown 8 feet wide and altitude 10 feet.

having these dimensions at a ratio of 1 to 3 is said to have a 1 over 3 slope, as represented by lines BC and AB in the same figure. Frequently levees are built with 1 over 2 slopes on the river sides and 1 over 3 slopes on the land sides, as shown also by this figure. This furnishes the embankments additional strength and increases the distance seepage water must travel.

In localities where seepage is abnormal and intense restraining powers become necessary the Mississippi River Commission advocates the adding of banquettes on the land sides, by beginning eight feet below the

crown and extending ten feet at a ratio of 1 to 10, then continuing for another ten feet at a rate of 1 to 4. Levees that conform in dimensions to those adopted by the Commission will evidently prove successful.

Crowns of levees are important factors and should be made wide, as each additional foot of top increases the horizontal thickness the same amount, the side slopes being kept constant. A wide crown furnishes opportunity in times of danger and necessity to increase the altitude considerably and immediately by storing sacks of sand. The Mississippi River Commission advocates an eight foot crown for levees constructed under its supervision.

Foundations for levees should be prepared with great care, by clearing the land of logs, leaves and other substances, and by removing the stumps, including all large roots, and then plowing the ground where the levees are to be placed as deeply as possible. The earth made loose by this work will unite with that built upon it for levee purposes and will become a part of the levees, which will then rest in grooves that will act as footings to hold them in place when the water pressure becomes severe. Many a levee that has given way before the waters reached the danger line would have stood firm had it been provided with a foundation as above described.

In order to supply substantial foundations and reduce opportunity for seepage, levees are sometimes provided with "muck ditches" to rest

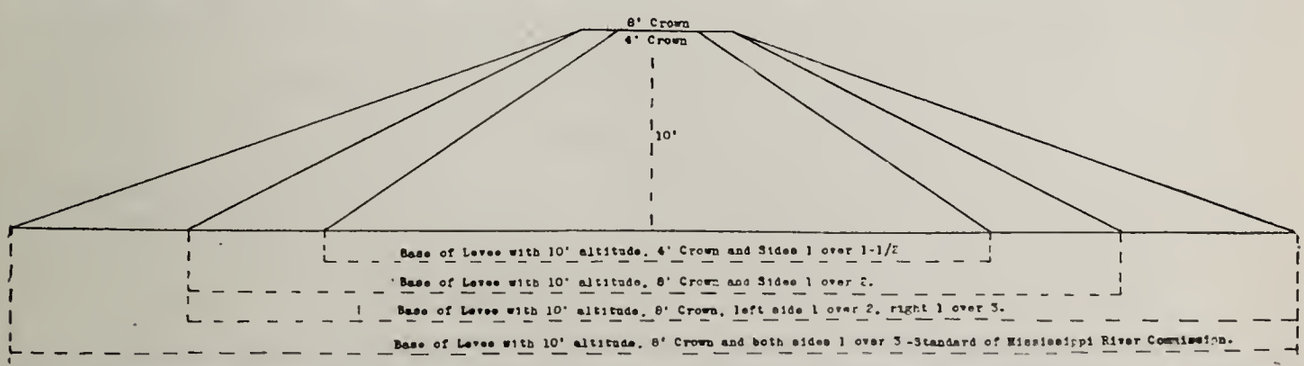

8' Crown
4' Crown
10'
Base of Levee with 10' altitude, 4' Crown and Sides 1 over 1-1/2
Base of Levee with 10' altitude, 8' Crown and Sides 1 over 2.
Base of Levee with 10' altitude, 8' Crown, left side 1 over 2, right 1 over 3.
Base of Levee with 10' altitude, 8' Crown and both sides 1 over 3 -Standard of Mississippi River Commission.

Fig. 2 indicates relative forms of levees having same altitude but different side slopes. Levee with 4-foot crown and side slopes 1 over 2 represents forms of early levees.

in. These are made by excavating trenches a number of feet deep and wide in the middle of the spaces where the levees are to be built, and then filling the same with earth having tenacity and that will pack closely. It is doubtful if the cost incurred for work of this kind supplies the same amount of strength to the embankments and affords the reduction in seepage that can be obtained by an equal expenditure of money for enlargement of bases or construction of banquettes.

Levees should be built out of "clean" earth—such as is free as possible of every substance foreign to itself. Logs, stumps, leaves and all other materials subject to decay and reduction in volume therefrom should never be included in levees. Soil particles unite with and adhere best to each other.

Alluvial deposits out of which levees must be built consist of clay, loam and sand. The former is often termed "gumbo," because of its sticky nature and levees built of it have given the greatest degree of satisfaction. They do not become watersoaked easily nor do they allow seepage. They retain their original forms and possess a great degree of resisting power. Loam, which is a mixture of sand, clay and organic matter, is a very light porous soil that soon becomes saturated with water. It lacks tenacity which means strength and is easily washed. Sand is not suitable for levee building because it is easily permeated by water and the waves and currents soon carry it away. It slips frequently when saturated and hard pressed.

But, as has been said by an eminent writer of this subject, usually the "engineer has very little choice as to the material he will use. It must be such as lies in front of the line he has located, and the location is generally determined by very different considerations than that of the quality of the material."

The river banks along which levees are built should receive the careful attention of the persons in charge of the work, especially after these embankments have been erected. They should be kept firm by the use of revetments and dikes.

The theory of supplying concrete cores for levees in order to add strength and prevent seepage, has been advanced by some persons, but it has not obtained much favor among the best experts in levee building. The impossibility of securing stable foundations is against the use of such work, were it otherwise practicable. These cores, if constructed, would gradually seek firm foundations by sinking into the soft earth, leaving hollow centers in the levees that would weaken them. Granting that these cores remained where formed, they would divide the levees into separate parts that would settle away from the solid center and thereby weaken the fortifications. The earth would not cling to the hard smooth concrete as strongly as it will to substances of its own nature, and the halves of the levees exposed to the rivers would prove easy preys to the lashing waves and swift currents.

Such reinforcements would be found too costly, were they otherwise practicable, as the strength they would supply could be obtained cheaper by increasing the cross sections of the embankments with earth.

Epitomizing what has been said in the foregoing paragraphs, it has been proven in many places of Missouri that levees can be built to keep back all floods; that levees properly built out of alluvial soil will be found to possess the required tenacity and strength; that levees, in order to give ample protection, must be erected above the floods planes; that their side slopes, which govern the width of the bases, must never be

less than 1 over 2, and generally a greater ratio is required; that suitable foundations should be prepared for the levees to rest in, and that no substances other than earth should be used in construction of embankments of this kind.

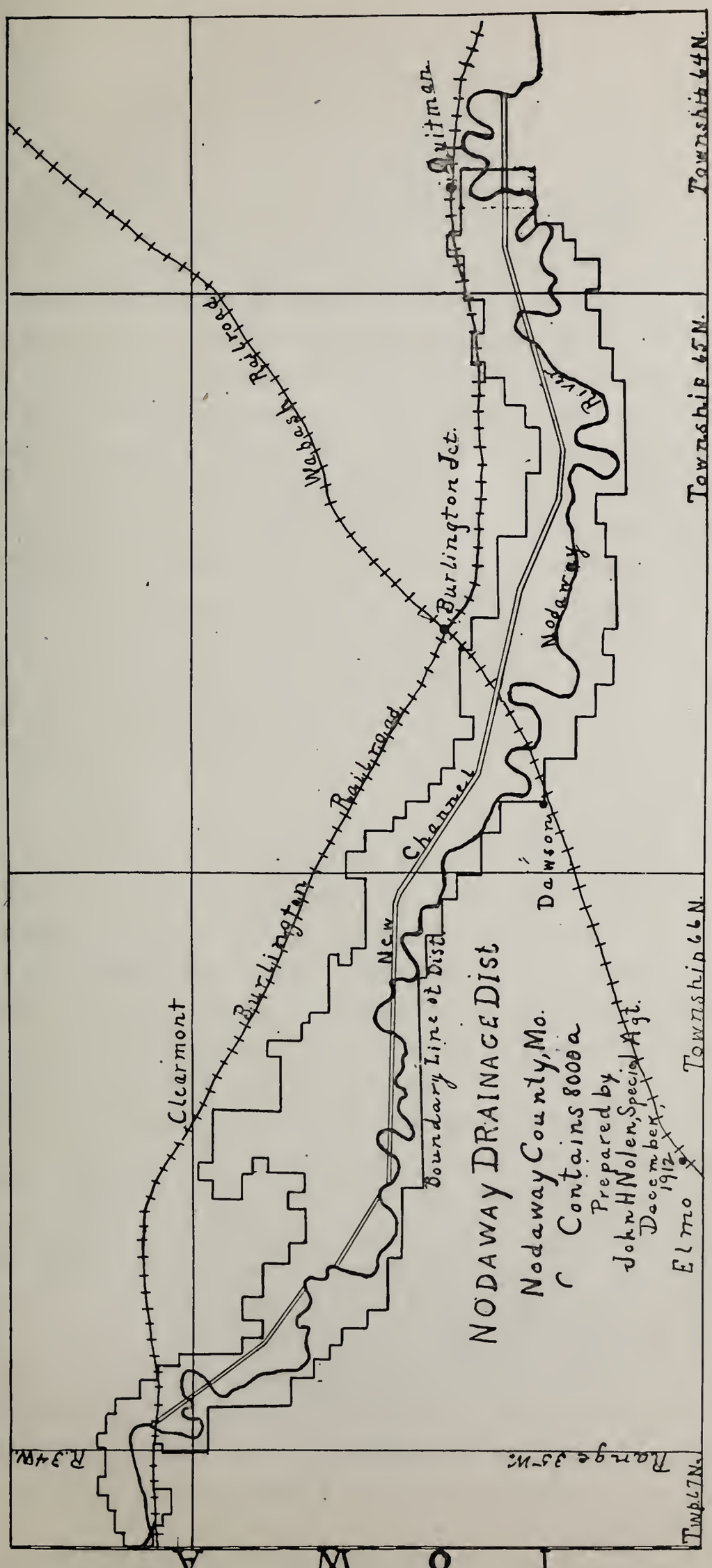
Such levee building as this will be more costly than some others at first, but it will prove a better investment in the long run. Future work of this class should be prosecuted with a view of furnishing certain defense from floods to the land for all times to come, for it will be an incentive for the owners to bring these lands under a higher state of cultivation and erect better improvements. Complete security can and must be supplied the rich overflowed alluvial areas of Missouri, and it is up to the landowners to furnish the funds to pay for this protection and to the engineers to work out the problems whereby it can be brought about.

THE LITTLE RIVER DRAINAGE DISTRICT.

The greatest drainage project in the United States is the Little River Drainage District in Southeast Missouri. A map showing the lands included in the district and the proposed ditches and levees for their reclamation, appears at another place in this report. The district embraces approximately five hundred and sixty thousand acres of swamp or overflowed lands situate in the counties of Bollinger, Cape Girardeau, Scott, Stoddard, New Madrid, Pemiscot and Dunklin. It is ninety miles in length from north to south, extending from the hills in Cape Girardeau and Bollinger counties to Arkansas line. The width of the district varies from four miles at its southern end to thirty miles across the north end. The general slope of the land surface is to the southwest, with an average fall of one foot to the mile. The fall along the north end from the west boundary to the Mississippi river averages a foot to the mile also. The land within this district is of the richest alluvial deposit. Geologists tell us that the Mississippi river once had for a part of its western bank, the hills and bluffs that extend from Cape Girardeau southwestward to Poplar Bluff, and that possibly an arm of the Gulf of Mexico once extended this far up the Mississippi valley. Numerous borings within the district reveal neither rock nor hardpan.

The watershed that drains into this district comprises 1,136 square miles, being a part of the eastern slope of the Ozark hills. The chief streams that come down out of the hill country into the district are the Castor river, Whitewater river, Crooked creek, Hubble creek, Ramsey creek, and a number of other smaller streams. The waters from these, after entering the low lands, soon leave their channels and spread out through numerous small sloughs and bayous and over the surface of the land. The lower lands in the district are covered with water to such an extent each year as to make them unfit for profitable cultivation in their present condition.

At present six per cent of the land within the district is cleared and cultivated to some extent, owing to its elevation and the condition of the season. The remaining ninety-four per cent is in timber, and is largely what is known as "cut-over land." The whole area was formerly covered with an exceptional heavy growth of gum, oak, cypress, ash, hickory, maple, elm, locust and catalpa trees. The average sale price of the land in the district, as disclosed by the land records of the several counties *during the past year,* was $36.34 per acre. The highest sale price within that period was $166.00 per acre.


Quitman
Wabash Railroad
Burlington Jct.
Burlington Railroad
Nodaway River
New Channel
Clearmont
Dawson
Boundary Line of Dist
NODAWAY DRAINAGE DIST
Nodaway County, Mo.
Contains 8000 a
Prepared by
John H Nolen, Special Agt.
December, 1912
Elmo
Township 65 N.
Township 64 N.
Township 66 N.
Range 35 W.
R. 34 W.
MISSOURI

The petition for the incorporation of this district was drawn in conformity with the requirements of chapter 41, article 1 of the R. S., 1909, and was filed in the circuit court of New Madrid county in September, 1905. It was signed by 66 per cent of the persons owning land within the district, and over 90 per cent of the persons owning land in the district either signed the petition or voluntarily entered their appearance when the case came up for hearing in the court.

The following year, 1906, a change of venue was taken from the circuit court of New Madrid county to the circuit court of Butler county, Missouri. Proceedings were had in the Supreme Court of the State for the purpose of determining whether or not a change of venue from the circuit court of one county to that of another county was legal. The Supreme Court, in a unanimous opinion, held that such a change of venue was legal, and on November 30, 1907, the circuit court of Butler county duly incorporated this district as a public corporation of the State. Three of the railroads having property within the district severally appealed from this judgment and decree of the circuit court incorporating the district, but the Supreme Court, in a unanimous opinion, affirmed the judgment of the Butler county circuit court. Not a single owner of land in the district appealed from the judgment of the circuit court.

After the district had been incorporated the landowners, in conformity with the law, met and elected John H. Himmelberger, A. J. Matthews, C. W. Henderson, S. P. Reynolds and A. L. Harty supervisors for the district. Each member of this board has been re-elected as their several commissions expired. John H. Himmelberger was elected president of the board and George S. Hanford was appointed secretary and treasurer. The law firm of Oliver & Oliver, Cape Girardeau, was employed as attorneys for the district. This firm had previously represented the petitioning landowners and they have continued to serve the district from the date of its organization.

The Board of Supervisors employed Otto Kochtitzky as chief engineer and William A. O'Brien and N. C. Frissell as assistant engineers of the district. The engineers first made a topographical survey of all the lands in the district, and later formulated a plan for drainage. This plan was submitted to and approved by Isham Randolph, Chicago, Illinois, one of the leading civil engineers of the United States, and a member of the Board of Consulting Engineers for the Panama Canal; the bureau of drainage investigation of the Federal Department of Agriculture, Washington, D. C., and Arthur E. Morgan, Civil Engineer, Memphis, Tennessee.

One feature of the "plan for drainage" necessitated the cutting of

R9E R10E R11E R12E R13E

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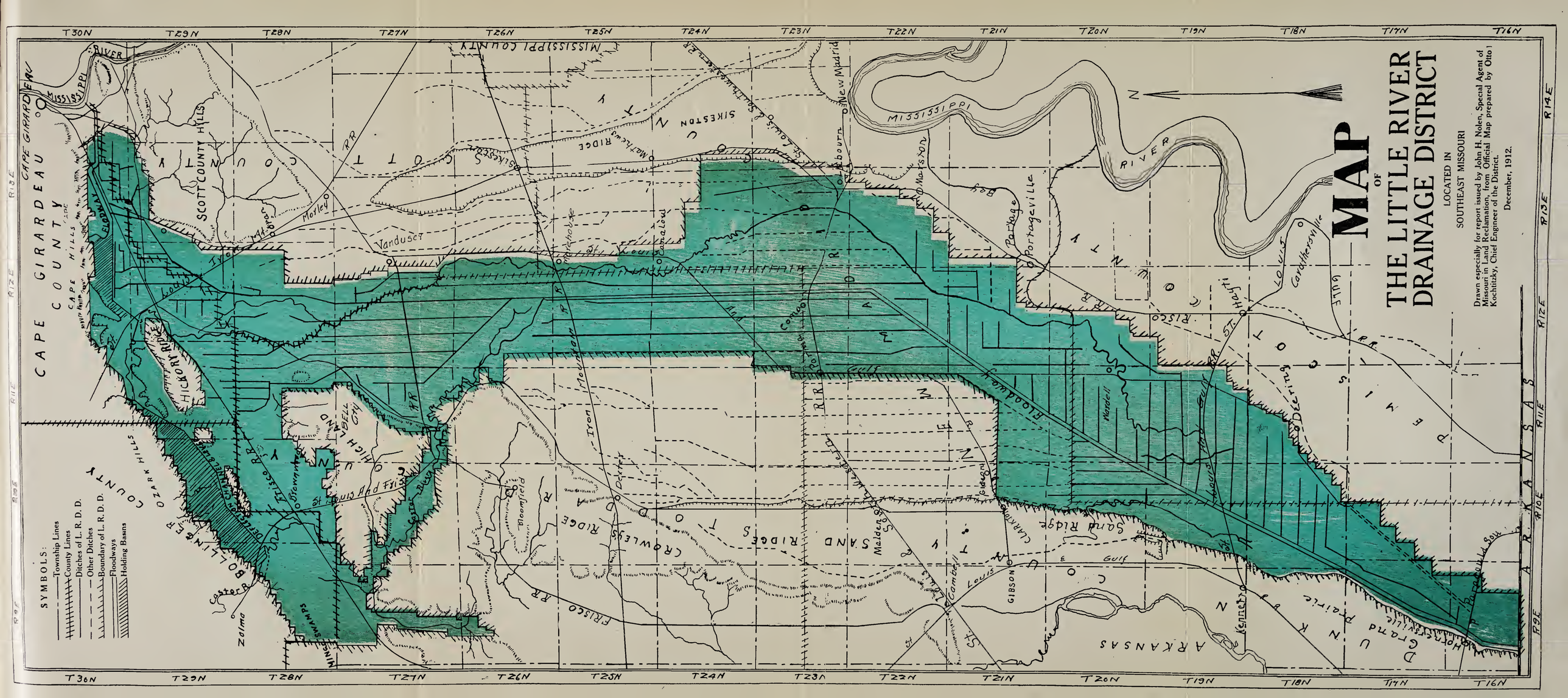

MAP
OF
THE LITTLE RIVER
DRAINAGE DISTRICT
LOCATED IN
SOUTHEAST MISSOURI
Drawn especially for report issued by John H. Nolen, Special Agent of Missouri in Land Reclamation, from Official Map prepared by Otto I Kochtitzky, Chief Engineer of the District.
December, 1912.
SYMBOLS:
Township Lines
County Lines
Ditches of L. R. D. D.
Other Ditches
Boundary of L. R. D. D.
Floodways
Holding Basins
CAPE GIRARDEAU COUNTY
SCOTT COUNTY
MISSISSIPPI COUNTY
NEW MADRID COUNTY
STODDARD COUNTY
DUNKLIN COUNTY
BOLLINGER COUNTY
CAPE GIRARDEAU
MISSISSIPPI RIVER
OZARK HILLS
CRUMLEY PRAIRIE
HICKORY RIDGE
CROWLEYS RIDGE
SAND RIDGE
BIG SWAMP
WHITE OAK SWAMP
BLOOMFIELD RIDGE
MALDEN RIDGE
SPARTA RIDGE
GRAND PRAIRIE
ARKANSAS
MISSISSIPPI RIVER
Cape Girardeau
Scott City
Morley
Vanduser
Sikeston
New Madrid
Portageville
Matthews
Bloomfield
Malden
Gibson
Kennett
Hornersville
Cardwell
Qulin
Deering
Hayti
Caruthersville
Gayoso
Gobbler
Tyler
Ivan
Parker
Crowley
Cairo
Louis
Gulf
Frisco
Iron Mountain
St. Louis & Southwestern R.R.
St. Louis, Iron Mountain & Southern R.R.
Cotton Belt R.R.
Floodway
Holding Basin
T30N
T29N
T28N
T27N
T26N
T25N
T24N
T23N
T22N
T21N
T20N
T19N
T18N
T17N
T16N
R9E
R10E
R11E
R12E
R13E
R14E
R15E
R16E

the United States Government levee south of Cape Girardeau, and the consent of the Mississippi River Commission to do this had to be secured before this "plan for drainage" could be adopted. Upon application, the War Department of the Government, through the Mississippi River Commission, consented to the diversion of these flood waters, and the cutting of its own levee, thereby indirectly approving the plan for this great undertaking.

Briefly stated, the plan for reclaiming this large body of land consists of:

First: A diversion channel and floodway, extending from the northwest corner of the district in an easterly direction along the base of the bluffs to the Mississippi river, just south of Cape Girardeau. This channel will be amply large to carry all the waters that come down out of the hill country from the north to the Mississippi river. Provision has been made for large basins just north of this diversion channel to receive and store the floodwaters until the crest of the flood can pass out eastward to the river. A large and strong levee is to be constructed immediately on the south of the diversion channel, forming a connection with the government levee so as to prevent any possible danger of flood waters, either from the hill country or from the floods of the Mississippi river, entering the lands of the district.

Second: A system of dredge ditches and canals, varying from ten to one hundred and fifty feet in width, will be dug practically a mile apart through the entire length of the district from north to south. These various ditches will articulate and finally terminate in one large canal in the south end of the district, which in turn will discharge the accumulated surface water of the district into Big Lake, Arkansas.

When completed there will be more than seven hundred miles of ditches and levees in this district, and some conception of the magnitude of the territory reclaimed may be gained when we realize that this drainage district includes within its boundaries nearly as many acres as there are in the state of Rhode Island. Some idea of the value and fertility of the lands to be reclaimed within the district may be had by reference to the magnificent farms that now skirt this district on both the east and west sides of it from Cape Girardeau to Arkansas. It is no exaggeration to say that no finer soil can be found in the United States than exists within the limits of this district.

After the "plan for drainage" had been approved by the engineers it was adopted by the Board of Supervisors, who in due time caused a copy of the "plan for drainage" to be filed with the clerk of the circuit court of Butler county, with a petition addressed to the judge of that court, the Honorable J. C. Sheppard, for the appointment of commis-

sioners to assess the benefits and damages to the lands in the district. The court appointed ex-Judge William C. Cracraft of Cape Girardeau county, ex-County Surveyor Orlando Reed of Stoddard county, and Luther Conrad, an extensive planter, of Dunklin county, as commissioners. They made a careful and painstaking examination of the lands within the district and filed their report with the clerk of the circuit court of Butler county after having devoted about ten months' time to this work. The Board of Supervisors of the district then levied a tax of twenty-five cents per acre on the lands within the drainage district, under section 5538, R. S., 1909, for the purpose of paying for the preliminary work of organizing the district and the assessing of benefits and damages. This tax was resisted by some three or four of the landowners in Cape Girardeau county. The circuit court of that county decided the case in favor of the district. The landowners appealed from that decision to the Supreme Court of the State, and that tribunal, in November, 1912, again sustained the district's contention by declaring this tax to be valid and that the statute did not violate either the Constitution of this State or of the United States.

Exceptions were filed to this report of the commissioners by some of the landowners owning land within the district. The jurisdiction of the circuit court of that county was assailed by these exceptors, and also by the railroads in the district. Proceedings were had in the Supreme Court of the State by some of these exceptors against the validity and jurisdiction of the circuit court of Butler county.

The Supreme Court again, in a unanimous opinion, sustained the district and the jurisdiction of the circuit court of Butler county. Soon after these decisions of the Supreme Court were rendered, the exceptions to the commissioners' report were speedily disposed of, and the circuit court of Butler county, after making some modifications of the report and adjusting some differences that naturally would arise in an enterprise of this magnitude, approved the report and entered its final decree affirming the same.

The benefits assessed against the lands in the district, as finally approved by the court, amount to more than thirteen and one-half million dollars.

Contracts for the construction of the drainage work were let by the Board of Supervisors in November, 1912, and it is expected that work will be commenced by the contractors in the early part of the year 1913. The contract provides that the work must be completed within thirty-six months after the sale of the bonds. The district will pay for this work by the issuing and sale of bonds, which bonds will be a lien on the five hundred and sixty thousand acres of land within the district. The

Board of Supervisors expect to make a sale of these bonds at par. Certainly no better investment can be found anywhere.

The cost of construction will be in the neighborhood of four million dollars, and it will perhaps take a half million more to pay for damages and rights of way and detention basins, making a total outlay of something over four and one-half million dollars.

The effect of the four decisions of the Supreme Court, above mentioned, settling and determining the questions involved in those suits is of the greatest value to the State at large. The effect is directly reflected by the market value of the lands within the drainage district being more than quadrupled, and indirectly in settling the same or like problems in other drainage districts of the State. Timbered lands within the district, at the time of the filing of the petition for the formation of the district, were selling from $3.00 to $10.00, depending upon their location, elevation and the quantity of timber standing on them, are now worth from $20.00 to $40.00. Drained and cleared lands of like soil on either side of this district are selling from $75.00 to $125.00 per acre.

TABULATED INFORMATION

The following tables contain information pertaining to drainage and levee districts in Missouri, taken, except in five instances, from the official records of the counties. Reports for all but two small districts of the State are included in these tables.

The total acreage, as shown in the first table, exceeds the actual amount of land benefited. This is due to many tracts being included in two or more districts.

When all the districts have been completed the total cost will exceed the amount shown in column three, as the costs of many districts had not been computed when these reports were made.

SUMMARY OF INFORMATION BY COUNTIES.

Name of County.	No. districts in county	Total acres in districts.	Total cost of districts.
Adair	1	6,306.00	$48,973.27
Atchison	8	53,547.00	354,880.00
Bates	1	41,350.00	426,731.32
Butler	7	244,504.26	288,472.48
Caldwell	2	2,617.00	30,641.25
Cape Girardeau	1	22,646.14	59,751.22
Carroll	7	108,900.00	371,100.00
Chariton	3	45,152.60	233,708.83
Clark	2	16,000.00	135,000.00
Clay	1	2,163.00	634,313.70
Dunklin	23	322,545.67	1,265,261.12
Henry	3	17,772.13	49,956.40
Holt	4	60,750.00	693,675.00
Howard	1	5,100.00	20,000.00
Jackson	1	1,650.00	.....
Johnson	2	27,437.00	399,761.30
Lincoln	3	28,600.00	63,000.00
Lafayette	5	12,971.68	50,459.00
Livingston	7	26,217.91	116,587.94
Macon	1	17,242.43	75,000.00
Marion	2	22,181.00	200,000.00
Mississippi	31	430,090.00	2,396,786.73
New Madrid	23	711,078.89	1,341,948.80
Osage	1	.....	.....
Nodaway	2	16,800.00	168,500.00
Pemiscot	8	701,061.57	3,037,433.01
Perry	2	25,420.00	196,157.49
Platte	1	10,000.00	15,000.00
Ray	5	18,105.00	89,825.00
Saline	4	7,349.00	27,709.60
Scotland	1	4,000.00	50,000.00
Shelby	1	4,708.28	45,000.00
Scott	8	210,921.70	780,649.88
St. Charles	3	12,473.58	15,054.38
St. Louis	1	1,610.22	6,922.00
Stoddard	21	306,913.76	2,497,126.28
Totals for State	* 197	3,546,185.82	$16,185,386.00

* Some districts contain land situate in two or more counties. The exact number of districts in the State is 191.

TABLE CONTAINING NAMES OF DISTRICTS, ACRES AND COST OF DISTRICTS AND OTHER INFORMATION.

Name of County	Law organized under	Name of Drainage or Levee District	Date incorporated or organized	Total acres in district	Total cost of district	Miles of ditches	Miles of levees	When completed
Adair	Circuit	Adair County Drainage District	Jan. 1909	6,306.00	$48,973.27	7.25	.....	Oct. 1912
Atchison	Circuit	Nishnabotna Drainage District	Feb. 18, 1892	12,400.00	40,000.00	6.00	.....	.....
Atchison	Circuit	Phelps City Dike and Drainage Dist.	Feb. 28, 1898	12,000.00	96,000.00	6.20	.....	.....
Atchison	Circuit	Mill Creek Drainage District	Feb. 28, 1898	1,965.00	15,720.00	3.00	.....	.....
Atchison	Circuit	Benton Township Drainage District	Oct. 24, 1899	5,760.00	46,000.00	6.00	2½	.....
Atchison	Circuit	N. Nishnabotna Drainage District	Nov. 7, 1906	8,000.00	64,000.00	7.25	.....	.....
Atchison	Circuit	Tarkio Drainage District No. 1	.....	7,327.00	55,000.00	11,00	.....	.....
Atchison	Circuit	Tarkio Drainage District No. 2	.....	3,895.00	30,160.00	6.75	.....	.....
Atchison	Circuit	Private Ditch	.....	2,200.00	8,000.00	4.25	.....	.....
		Totals for County	.....	53,547.00	$354,880.00			
Bates	County	Bates County Drainage District No. 1	May 1906	41,350.00	$426,731.32	36.00	.....	May 1913
Butler	Circuit	Butler County Levee District	.....	3,000.00	.....	.....	9	.....
Butler	Circuit	Inter-River Drainage District	.....	127,422.26	.....	20.00	.....	.....
Butler	Circuit	Little River Drainage District	Dec. 20, 1907	*	.....	.....	.....	.....
Butler	County	Butler County Drainage District No. 3	1899	6,200.00	3,408.00	18.00	.....	1901
Butler	County	Butler County Drainage District No. 7	1906	84,058.00	277,000.00	80.00	.....	1908
Butler	County	Butler County Drainage District No. 8	1907	3,824.00	8,064.48	.....	.....	1909
Butler	County	Butler County Drainage District No. 10	1912	20,000.00	.....	33.25	.....	.....
		Totals for County	.....	244,504.26	$288,472.48			
Caldwell	County	Caldwell County Drainage Dist. No.19	July 5, 1910	1,978.00	$22,631.25	7.75	.....	Oct. 30, 1912
Caldwell	County	Caldwell County Drainage Dist. No.20	Oct. 3, 1910	639.00	8,010.00	2.75	.....	Sept. 20, 1912
				2,617.00	$30,641.25			

Carroll	Circuit	Norborne Land Drainage District	July 6, 1899	14,400.00	65,000.00	12.00		1898
Carroll	Circuit	Island Slough Levee District	Dec. 16, 1909	1,000.00	8,900.00		4.5	
Carroll	Circuit	Sugar Tree Levee District No. 1	Oct. 20, 1909	4,000.00	4,000.00		4.0	1909
Carroll	County	Sambo Slough Levee District	Sept. 10, 1909	11,000.00	15,200.00		7,0	1909
Carroll	County	Sugar Tree Drainage District	1906	6,500.00	34,000.00	7.0		1910
Carroll	County	Miami Levee and Drainage District	1909	2,000,00	9,000.00	2.5	2.0	1910
Carroll	County	Drainage District No. 3	1906	70,000.00	235,000,00	21.0	.5	Under Const.
				108,900.00	$371,100.00			
Cape Girardeau	Circuit	Little River Drainage District †	Dec. 18, 1907	22,646.14	$59,751.22			
Chariton	County	Chariton County Drainage Dist. No. 4	1904	2,845.13	$34,479.83	4		1905
Chariton	County	Chariton County Drainage Dist. No. 5	1904	40,654.47	183,117.00	34.50		1906
Chariton	County	Chariton County Drainage Dist. No. 7	1906	1,653.00	16,112.00	1.5		1907
				45,152.60	$233,708.83			
Clark	Circuit	Wyaconda Drainage District No. 1	June 20, 1911	6,000.00	$50,000.00	12.50	11	1913
Clark	Circuit	Des Moines and Mississippi Levee Dist. No. 1	1903	10,000.00	85,000.00	9.50		
				16,000.00	$135,000.00			
Clay	Circuit	North Kansas City Levee District	Nov. 27, 1909	2,163.00	$634,313.70		37,300 ft.	1913
Dunklin	County	Dunklin County Drainage Dist. No. 1		16,340.00	$44,764.15			
Dunklin	County	Dunklin County Drainage Dist. No. 2		19,280.00	49,987.35			
Dunklin	County	Dunklin County Drainage Dist. No. 3		15,680.00	50,656.71			
Dunklin	County	Dunklin County Drainage Dist. No. 4		14,750.00	46,737.33			
Dunklin	County	Dunklin County Drainage Dist. No. 5		16,920.00	51,615.62			
Dunklin	County	Dunklin County Drainage Dist. No. 10		7,340.00	16,855.69			
Dunklin	County	Dunklin County Drainage Dist. No. 11		2,760.00	4,816.85			
Dunklin	County	Dunklin County Drainage Dist. No. 12		20,800.00	54,136.96			
Dunklin	County	Dunklin County Drainage Dist. No. 13		3,040.00	8,662.40			
Dunklin	County	Dunklin County Drainage Dist. No. 14		1,320.00	2,292.51			
Dunklin	County	Dunklin County Drainage Dist. No. 15		2,160.00	3,265.21			

* Land in Little River Drainage District situated in Cape Girardeau, Dunklin, New Madrid, Pemiscot, Scott and Stoddard counties. Each county has been credited with its portion of this district.

† Incorporated in Butler County.

TABLE CONTAINING NAMES OF DISTRICTS, ACRES AND COST OF DISTRICTS AND OTHER INFORMATION—Continued.

Name of County	Law organized under	Name of Drainage or Levee District	Date incorporated or organized	Total acres in district	Total cost of district	Miles of ditches	Miles of levees	When completed
Dunklin	County	Dunklin County Drainage Dist. No. 16		2,350.00	4,676.25			
Dunklin	County	Dunklin County Drainage Dist. No. 17		2,160.00	1,265.21			
Dunklin	County	Dunklin County Drainage Dist. No. 18		2,834.00	12,722.25			
Dunklin	County	Dunklin County Drainage Dist. No. 19		14,296.77	106,374.45			
Dunklin	County	Dunklin County Drainage Dist. No. 20		2,680.00	10,236.71			
Dunklin	County	Dunklin County Drainage Dist. No. 21		10,160.00	29,503.73			
Dunklin	County	Dunklin County Drainage Dist. No. 23		1,840.00	1,162.00			
Dunklin	County	Dunklin County Drainage Dist. No. 24		950.00	10,230.80			
Dunklin	County	Dunklin County Drainage Dist. No. 25		26,638.25	109,816.27			
Dunklin	County	Dunklin County Levee District No. 2		44,880.00	18,900.00			
Dunklin	County	Dunklin County Levee District No. 4		42,240.00	40,160.00			
Dunklin	Circuit	Little River Drainage District..*	Dec. 8, 1907	51,126.65	586,422.67			
				322,545.67	$1,265,261.12			
Henry	Circuit	Grand River Drainage District	Jan. 26, 1909	5,947.03				
Henry	Circuit	Pioneer Drainage District	Sept. 26, 1907	7,282.00				
Henry	County	Big Creek Drainage District No. 1	March 7, 1910	4,543.10	$49,956.40	6.39		July 27, 1913
				17,772.13	$49,956.40			
Holt	Circuit	Squaw Creek Drainage District	May 22, 1900	19,500.00	80,000.00	19		1899
Holt	Circuit	Big Tarkio Drainage District	March 1910	22,500.00	347,000.00	6.7		1899
Holt	Circuit	Mill Creek Drainage District	Sept. 6, 1907	7,000.00	86,675.00	8		Sept. 1908
Holt	Circuit	Little Tarkio Drainage District	Sept. 4, 1910	6,500.00	90,000.00	5		March 1, 1912
Holt	Circuit	Nodaway Drainage District No. 1	Sept. 8, 1905	5,250.00	90,000.00	6		
				60,750.00	$693,675.00			

* Incorporated in Butler County.

Howard	Circuit	Howard County Levee District No. 2		1910	5,100.00	$20,000.00	3	8	1911
Jackson	Circuit	Blue Bottom Levee Dist. Jackson Co		1911	1,650.00			5	
Johnson	County	Big Creek Drainage Dist. Johnson Co	Dec. 6,	1909	4,353.00	59,761.30	6.4		Feb. 1, 1913
Johnson	Circuit	Black Water Drainage Dist. No. 1	Nov. 23,	1909	23,084.00	340,000.00	27		March 1, 1913
					27,437.00	$399,761.30			
Lincoln	Circuit	Elsberry Drainage District	April 13,	1911	25,000.00				
Lincoln	County	Cap au Gris Drainage and Levee Dist		1892	1,100.00	18,000.00	5	15	1899
Lincoln	County	Kings Lake Drainage District		1893	2,500.00	45,000.00		19	1900
					28,600.00	$63,000.00			
Lafayette	County	F. W. Brand Drainage District	Aug.	1906	3,048.68	$18,051.00	9.52		March 1, 1909
Lafayette	County	J. W. Bricken Drainage District	Aug.	1906	840.00	4,037.00	3		1908
Lafayette	County	Joseph Crutsinger Drainage District	Nov.	1904	940.00	2,104.00	1 5/8		1905
Lafayette	County	J. W. Thompson Levee District	Nov.	1907	5,000.00	11,492.00	1 1/5		1908
Lafayette	County	W. T. Shamel Drainage Co	Dec. 7,	1908	3,143.00	14,775.00	9 1/6		1910
					12,971.68	$50,459.00			
Livingston	County	Drainage District No. 4	Nov.	1905	3,280.00	$11,466.00	3.5		Dec. 1907
Livingston	County	Sampsel Drainage District No. 8	Nov.	1907	6,821.00	14,000.00	5.4		Dec. 1911
Livingston	County	Kinsella Drainage District No. 10	Feb.	1908	1,048.50	3,924.00	1.6		Feb. 1909
Livingston	County	Shoal Creek Drainage District No. 13	Aug.	1909	7,524.00	46,719.40	9.8		Dec. 1911
Livingston	County	Sutherland Drainage District No. 15	Feb.	1910	3,964.41	14,725.74	2.9		Dec. 1911
Livingston	County	Clark Drainage District No. 18	Aug.	1910	2,240.00	12,466.40	4.9		Oct. 1912
Livingston	County	Scitter Drainage District No. 19	Nov.	1910	1,340.00	13,286.40	2.8		Dec. 1912
					26,217.91	$116,587.94			
Macon	Circuit	Chariton Drainage District No. 1	April 29,	1904	17,242.43	$75,000.00	12.5		
Marion	Circuit	Fabius River Drainage District	April 24,	1911	11,181.00				
Marion	County	South River Levee District		1903	11,000.00	200,000.00	13.25		1904
					22,181.00	200,000.00			
Mississippi	County	Chapman-Beckwith Drainage District							

TABLE CONTAINING NAMES OF DISTRICTS, ACRES AND COST OF DISTRICTS AND OTHER INFORMATION.—Continued

Name of County	Law organized under	Name of Drainage or Levee District	Date incorporated or organized	Total acres in district	Total cost of district	Miles of ditches	Miles of levees	When completed
Mississppii	County	Wolf Hole Drainage District No. 1	Oct. 3, 1898	.....	$8,000.00	47,200 ft.	.....	1905
Mississippi	County	Maple Slough Drainage District No. 2.	Feb. 10, 1900	6,000.00	33,427.46	126,000 ft.	.....	1902
Mississippi	County	Ash Slough Drainage District No. 3	June 11, 1900	20,000.00	14,895.00	27,000 ft.	.....	1907
Mississippi	County	Rowe Drainage District No. 4	Sept. 22, 1900	.....	.....			
Mississippi	County	Fish Lake Drainage District No. 5	Nov. 14, 1900	22,000.00	31,000.00	20.	.....	1908
Mississippi	County	White Pond Drainage District No. 6	Dismissed					
Mississippi	County	Stephens Bayou Drainage Dist. No. 7	Abandoned					
Mississippi	County	Mound Ridge Slough Drain. Dist. No. 8	Abandoned					
Mississippi	County	Swan Pond Drainage District No. 9	Dismissed.					
Mississippi	County	Mississippi and New Madrid District No. 10	May 5, 1905	6,000.00	17,590.00	15	.....	Sept. 1906
Mississippi	County	Allen-Beck Drainage District No. 11	Nov. 8, 1905	2,000.00	2,338.00	7,800 ft.	.....	Feb. 3, 1909
Mississippi	County	Hunters Drainage District No. 12	Dismissed.					
Mississippi	County	Shelby Drainage District No. 13	Dismissed.					
Mississippi	County	Lee-Rowe Drainage District No. 14	June 1908	55,626.00	230,629.00	12.6	.....	1911
Mississippi	County	French-Wyatt Drainage Dist. No. 15	Abandoned,					
Mississippi	County	Newlee Drainage District No. 16	Dismissed.					
Mississippi	County	Texas Bend Drainage District No. 17.	Aug. 28, 1906	2,000.00	6,094.00	10,800 ft.	.....	1908
Mississippi	County	Wm. Hunter Drainage District No. 18	.....	62,394.00	337,675.00			
Mississippi	County	Henry Vowell Drainage District No. 19	Dec. 17, 1906	21,561.00	71,897.67			
Mississippi	County	Marshall-Rowling Drain. Dist. No. 20.	June 24, 1907	2,000.00	4,985.23	9,890 ft.	.....	1909
Mississippi	County	W. S. Davidson Drainage District No21	Dismissed.					
Mississippi	County	Holloway-Hunter Drain. Dist. No. 22	Aug. 5, 1909					
Mississippi	County	Mark-Grant Drainage District No. 23	Feb. 7, 1910	46,636.00	311,752.00	136,000 ft.	.....	1909
Mississippi	County	Byrd-Goodin Drainage Dist. No. 24	Consolidated	with No. 23				
Mississippi	County	Crow-Vowells Drainage Dist. No. 25	Oct. 22, 1910	8,273.00	42,503.37	39,000 ft.	.....	Dec. 31, 1912
Mississippi	County	Hendrix et al Drainage Dist. No. 26	Marc 17, 1911	Abandoned				
Mississippi	Circuit	Big Lake Drainage and Levee District						
Mississippi	County	Adams-Tyler Drainage Dist. No. 28	Dec. 18. 1911	1,600.00	.....	8,530 ft.	.....	1913
Mississippi	County	Mississippi County Levee Dist. No. 1	1892	170,000.00	1,200,000.00	.....	45	1913

Mississippi	County	Mississippi County Levee Dist. No. 2.		1895	4,000.00	84,000.00	.....	.....	1913
					430,090.00	$2,396,786.73			
New Madrid	County	Drainage District No. 1		1898	43,312.00	$86,323.88	46	.....	1900
New Madrid	County	New Madrid Co. Drainage Dist. No. 2		1899	1,600.00	1,400.00	1.5	.....	1899
New Madrid	County	New Madrid Co. Drainage Dist. No. 3		1900	2,000.00	7,300.00	5	.....	1900
New Madrid	County	New Madrid Co. Drainage Dist. No. 5		1899	14,611.00	80,000.00	27	.....	1901
New Madrid	County	New Madrid Co. Drainage Dist. No. 5½		1900	5,120.00	16,000.00	4	.....	1901
New Madrid	County	New Madrid Co. Drainage Dist. No. 7		1900	68,660.00	268,624.75	123	.....	1904–1905–1907
New Madrid	County	New Madrid Co. Drainage Dist. No. 9		1902	14,335.00	17,765.55	17	.....	1903
New Madrid	County	New Madrid Co. Drainage Dist. No. 10		1901	7,104.00	24,427.91	17	.....	1902
New Madrid	County	New Madrid Co. Drainage Dist. No. 12		1903	25,000.00	55,216.49	18	.....	1906
New Madrid	County	New Madrid Co. Drainage and Levee District No. 13		1903	9,886.00	40,910.94	16	10	1909
New Madrid	County	New Madrid Co. Drainage Dist. No. 14		1905	3,020.00	11,176.20	9	.....	1913
New Madrid	County	New Madrid Co. Drainage Dist. No. 15		1905	18,948.00	52,000.00	18	.....	1908
New Madrid	County	New Madrid Co. Drainage Dist. No. 16		1906	800.00	2,260.00	1.5	.....	1907
New Madrid	County	New Madrid Co. Drainage Dist. No. 18		1905	18,262.00	45,115.14	17	.....	1910
New Madrid	County	New Madrid Co. Drainage and Levee District No. 19		1906	37,773.00	180,000.00	62	7	1909
New Madrid	County	New Madrid Co. Drainage Dist. No. 20		1907	516.00	1,121.00	2.5	.....	1908
New Madrid	County	New Madrid Co. Drainage Dist. No. 21		1907	2,712.00	6,200.00	3	.....	1913
New Madrid	County	New Madrid Co. Drainage Dist. No. 22		1907	4,040.00	12,951.80	9	.....	1912
New Madrid	County	New Madrid Co. Drainage Dist. No. 23		1907	31,460.00	51,944.86	.....	.....	1911
New Madrid	County	New Madrid Co. Drainage Dist. No. 26		1909	29,765.00	92,000.00	14	.....	1913
New Madrid	Circuit	St. John's Levee and Drainage District	March	1912	75,000.00	.....		.....	
New Madrid	County	Levee Contract District	.....	.....	150,000.00	125,000.00	35	.....	1899
New Madrid	Circuit	Little River Drainage District*	Dec. 18,	1907	143,164.89	164,210.28	35	.....	
					711,078.89	$1,341,948.80			
Osage	County	Shawnee Creek Drainage District of Osage County	Nov. 4,	1912	.....	.....	.....	.....	.....
Nodaway	Circuit	One-hundred and Two Drainage district No. 1	April 5,	1905	8,800.00	48,500.00	.....	15	.....
Nodaway	Circuit	Nodaway Drainage District No. 2	July 1,	1909	8,000.00	120,000.00	.....	12	Jan. 1913
					16,800.00	$168,500.00			

TABLE CONTAINING NAMES OF DISTRICTS, ACRES AND COST OF DISTRICTS AND OTHER INFORMATION—Continued.

Name of County	Law organized under	Name of Drainage or Levee District	Date incorporated or organized	Total acres in district	Total cost of district	Miles of ditches	Miles of levees	When completed
Pemiscot	Circuit	Little River Drainage District *	Dec. 8, 1907	74,801.57	$857,973.90			
Pemiscot	County	St. Francis Levee District †	1993	‡292,000.00	$580,442.00	48.5		
Pemiscot	County	Tanners Lake	May 2, 1899	44,000.00	21,315.17	17		
Pemiscot	County	District No. 1	May 7, 1901	71,000.00	102,610.46	32		
Pemiscot	County	District No. 3	Feb. 15, 1904	27,260.00	97,832.38	19		
Pemiscot	County	District No. 6	April 8, 1908	87,000.00	542,564.50	41		
Pemiscot	County	District No. 8	Sept. 25, 1911	91,000.00	668,866.65	47		
Pemiscot	County	District No. 9	Sept. 31, 1911	14,000.00	165,827.95	24		
				701,061.57	$3,037,433.01			
Perry	County	Perry County Levee District No. 1	1894	10,000.00	$25,000.00	5	10	1895
Perry	County	Drainage District No. 1	June 1, 1911	15,420.00	171,157.49			1913
				25,420.00	$196,157.49			
Platte	County	Platte County Drainage Dist. No. 1		10,000.00	$15,000.00	4		
Ray	County	Willow Drainage District	April 6, 1909	1,900.00	17,000.00	6		1911
Ray	County	Crooked River Drainage District	Oct. 9, 1911	5,460.00	38,500.00	5.25		
Ray	County	Ray County Levee District No. 1	April 4, 1906	2,845.00	9,845.00		1.75	1909
Ray	County	Ray County Levee District No. 2	Feb. 7, 1910	2,580.00	15,480.00		6.25	1911
Ray	County	Ray County Levee District No. 3	May 2, 1910	5,320.00	9,000.00		1.25	1911
				18,105.00	$89,825.00			

* Incorporated in Butler County.

† Organized by special act of the Legislature.

‡ This sum comprises all of the lands in Pemiscot County. In addition to this amount 43,000 acres are located in New Madrid county and 52,000 acres in Dunklin.

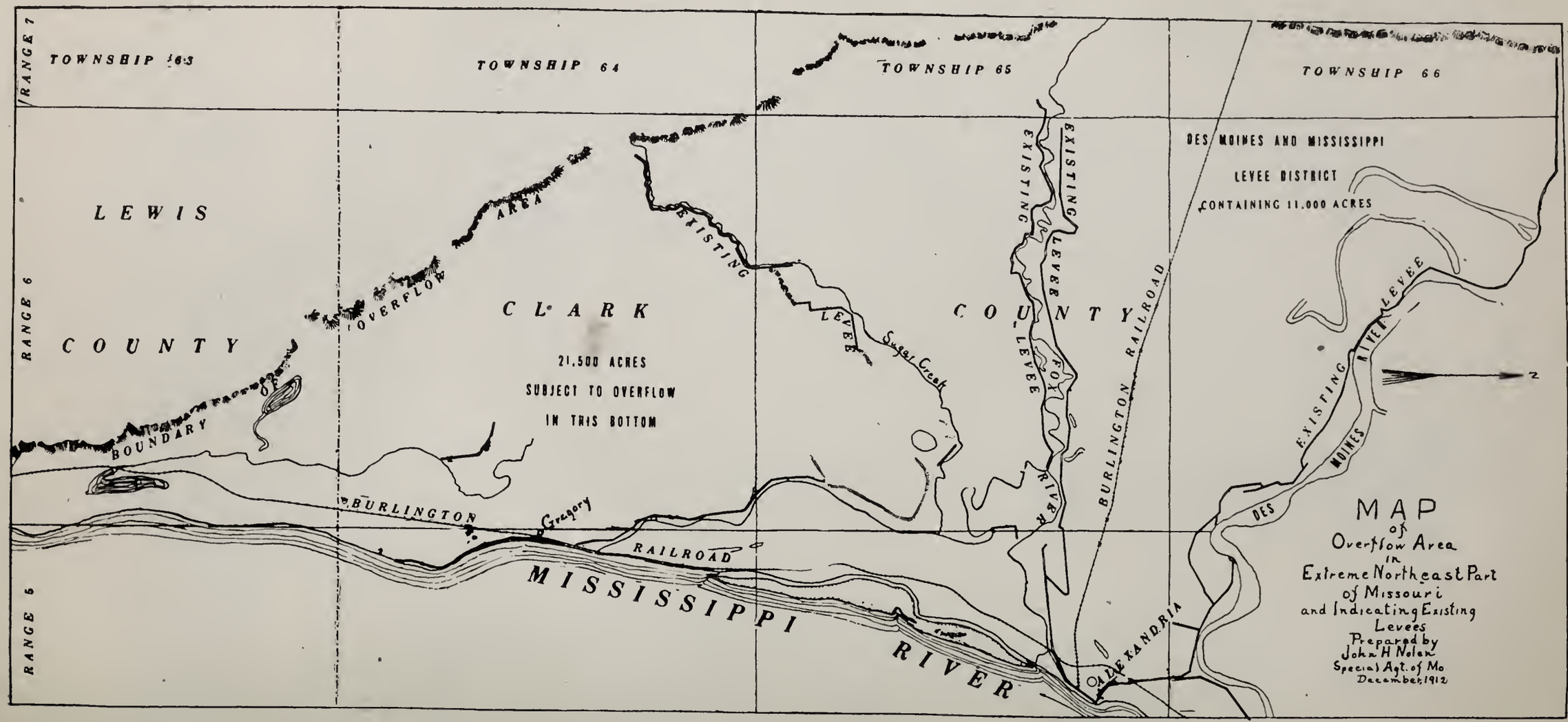
Saline	County	Gilham Lake Drainage and Levee District No. 1		1912	1,260.00	16,950.00	26,000 ft.	26,000 ft.
Saline	County	Cole's Lake Drainage District No. 2		1912	2,250.00			
Saline	County	Salt Branch Drainage and Levee Dist.		1905	1,339.00	10,759.60	24,000 ft.	24,000 ft. 1906
Saline	Circuit	Malta Bend Levee District	Jan. 17,	1911	2,500.00			
					7,349.00	$27,709.60		
Scotland	County	Fabius Drainage District No. 1		1909	4,000.00	$50,000.00	15.25	Sept. 1912
Shelby	Circuit	Valley Drainage District	April 4,	1911	4,708.28	45,000.00	31,500 ft.	April 1, 1913
Scott	County	Scott County Drainage District No. 1	Sept. 2,	1899	41,668.00	55,448.99	21	Oct. 1900
Scott	County	Scott County Drainage District No. 2	March 8,	1899	28,671.00	38,218.08	16	May 22, 1901
Scott	County	Scott County Drainage District No. 3	Aug. 7,	1899	35,509.01	94,924.81	32	Aug. 6, 1900
Scott	County	Scott County Drainage District No. 4	Mar. 13,	1906	33,944.64	94,538.80	31	June 24, 1912
Scott	County	Scott County Drainage District No. 5	Sept. 26,	1906	7,465.81	18,000.00	9	Mar. 4, 1912
Scott	County	Scott County Drainage District No. 6	Aug. 1,	1910	2,590.72	12,500.00	4.75	Feb. 1913
Scott	County	Scott County Drainage District No. 10	April 7,	1911	26,982.79	76,000.00	21	Sept. 4, 1914
Scott	Circuit	Little River Drainage District*	Dec. 18,	1907	34,089.73	391,019.20		
					210,921.70	$780,649.88		
St. Charles	County	Elm Point Drainage District No. 1	Feb. 15,	1910	646.03	$2,417.62	5,494 ft.	Sept. 13, 1911
St. Charles	County	Marais Croche Lake Drainage District	April 26,	1910	3,301.07	4,780.68	8,156 ft.	Dec. 13, 1911
St. Charles	County	Dardenne Drainage District No. 3	Aug. 24,	1911	8,526.48	7,856.08	⅓	Dec. 1, 1912
					12,473.58	$15,054.38		
St. Louis	County	Bonfils Drainage District	Mar. 18,	1899	1,610.22	$6,922.00		
Stoddard	County	West Swamp Drainage District No. 1		1901	11,660.00	21,557.70	36,600 ft.	Mar. 1, 1903
Stoddard	County	R. A. Sisler Drainage District No. 2	May 20,	1901	20,393.86	71,670.00	15	Mar. 1, 1903
Stoddard	County	D. L. Langley Drainage District No. 3	Dismissed.					
Stoddard	County	Arnold Drainage District No. 4	Nov. 11,	1903	18,373.14	66,682.00	20	May 1908
Stoddard	County	W. E. Edmonds Drainage Dist. No. 5	Aug. 1,	1904	9,838.70	36,461.85	23,600 ft.	Feb. 19, 1907
Stoddard	County	A. H. Carter Drainage District No. 6	Feb. 1,	1904	13,090.40	63,713.17	93,900 ft.	Jan. 1, 1906
Stoddard	County	R. L. Snider Drainage District No. 7	May	1906	21,092.36	73,379.92	95,000 ft.	Dec. 31, 1910

*Incorporated in Butler County.

TABLE CONTAINING NAMES OF DISTRICTS, ACRES AND COST OF DISTRICTS AND OTHER INFORMATION—Continued.

Name of County	Law organized under	Name of Drainage or Levee District	Date incorporated or organized	Total acres in district	Total cost of district	Miles of ditches	Miles of levees	When completed
Stoddard	County	N. M. Cobb Drainage District No. 10.	Dec. 5, 1906	3,044.82	$10,898.49	35,196 ft.	.....	May 6, 1908
Stoddard	County	J. A. Montgomery Drainage Dist. No.8	June 3, 1907	4,925.65	.....	46,700 ft.	.....	.....
Stoddard	County	Asa Norman Drainage District No. 9..	Jan. 2, 1908	Dismissed.				
Stoddard	County	Minton Drainage District No. 12.....	Jan. 6, 1908	48,702.11	197,445.57	95,000 ft.	.....	.....
Stoddard	County	Magee Drainage District No. 11.....	Aug. 19, 1909	2,660.00	Dismissed.			
Stoddard	County	R. L. Guy Drainage District No. 13...	July 5, 1910	1,500.00	1,982.00	17,991 ft.	.....	Jan. 25, 1912
Stoddard	County	J. P. Dunn Drainage District No. 14..	Mar. 7, 1911	1,964.00	4,695.00	24,815 ft.	.....	Nov. 1912
Stoddard	County	Thos. Connelly Drainage Dist. No. 15	July 3, 1911	11,288.03	47,361.00	39,478 ft.	.....	Sept. 1, 1913
Stoddard	County	A. F. Asa Drainage District No. 16...	Dismissed.					
Stoddard	County	K. S. Spence Drainage District No. 17	Sept. 18, 1911	Dismissed.				
Stoddard	County	J. P. Larue Drainage District No. 19..	Sept. 10, 1912	No report.				
Stoddard	County	Ref. J. P. Ward et al No. 1.....	.....	10,571.78	595,846.70	.....	.....	.....
Stoddard	County	Ref. J. N. Miller et al No. 2.....	.....	13,908.92	.....	.....	.....	.....
Stoddard	Circuit	Little River Drainage District*	Dec. 8, 1907	113,899.99	1,305,432.88	.....	.....	.....
				306,913.76	$2,497,126.28			

*Incorporated in Butler County.


RANGE 7
TOWNSHIP 63
TOWNSHIP 64
TOWNSHIP 65
TOWNSHIP 66
RANGE 6
LEWIS
COUNTY
CLARK
COUNTY
OVERFLOW AREA
EXISTING LEVEE
Sugar Creek
EXISTING LEVEE
EXISTING LEVEE
FOX RIVER
BURLINGTON RAILROAD
DES MOINES AND MISSISSIPPI
LEVEE DISTRICT
CONTAINING 11.000 ACRES
EXISTING LEVEE
DES MOINES RIVER
21.500 ACRES
SUBJECT TO OVERFLOW
IN THIS BOTTOM
BOUNDARY
BURLINGTON
Gregory
RAILROAD
MISSISSIPPI RIVER
RANGE 6
ALEXANDRIA
MAP
of
Overflow Area
in
Extreme Northeast Part
of Missouri
and Indicating Existing
Levees
Prepared by
John H Nolen
Special Agt. of Mo
December 1912

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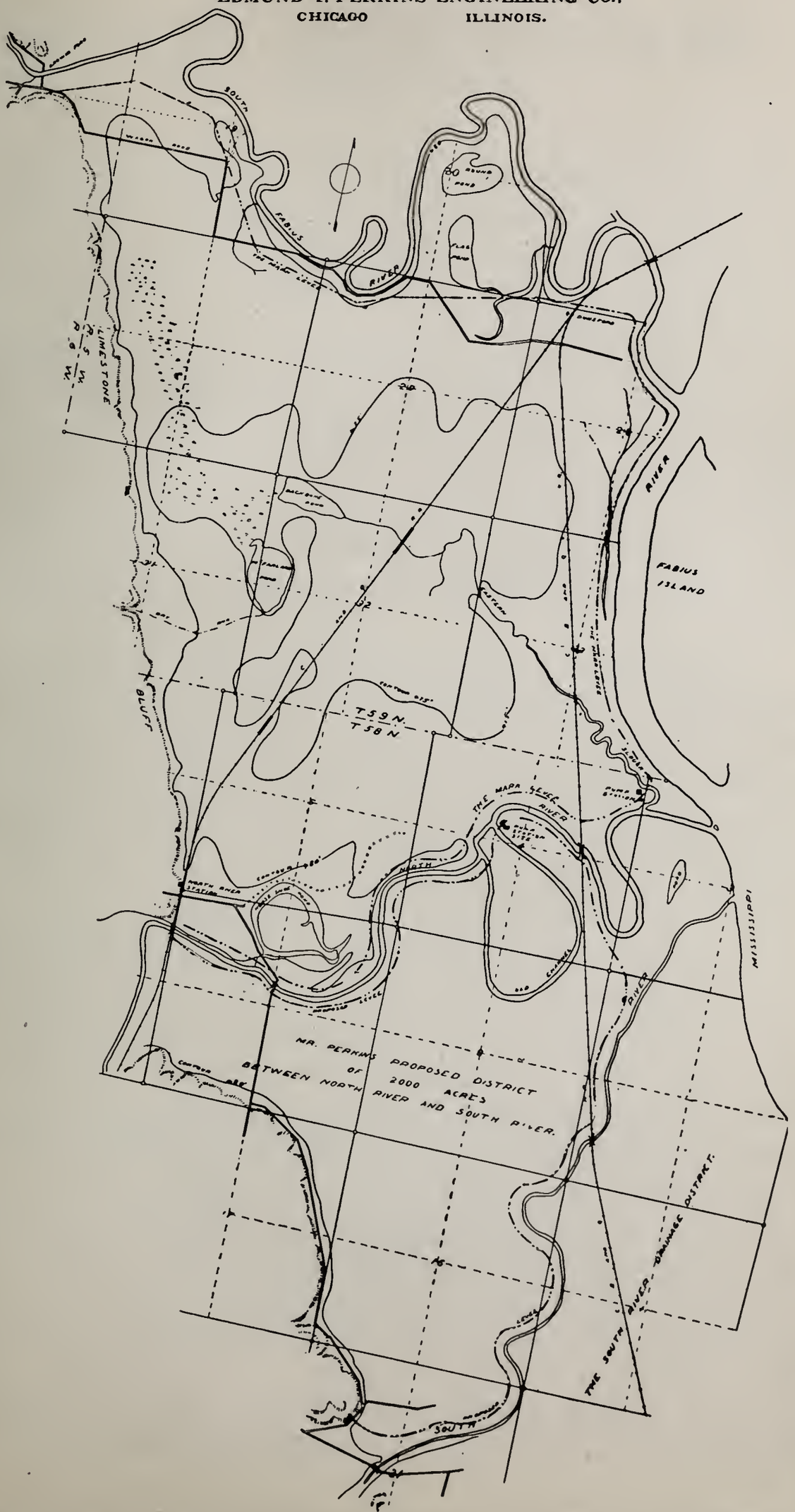
LIST OF DRAINAGE AND LEVEE DISTRICTS ORGANIZED IN MISSOURI UNDER ARTICLES I AND IX, CHAPTER 41, REVISED STATUTES, 1909.

Name of levee or drainage district.	County in which incorporated.	Date of incorporation.
Sugar Creek Drainage District	Platt	October 6, 1883.
Drainage District No. 1	St. Charles	June 28, 1884.
Nishnabotna Drainage D str ct	Atchison	February 18, 1892.
Mill Creek Drainage District	Atchison	February 28, 1893.
Phelps City Dike and Drainage District No. 1	Atchison	February 28, 1898.
Norborne Land and Drainage Company	Carroll	July 6, 1899
Benton Township Dike and Drainage District	Atchison	October 24, 1899.
Big Tarkio Drainage District	Holt	February 3, 1900.
East Mill Creek Drainage District	Atchison	February 12, 1900.
Squaw Creek Drainage District No. 1	Holt	June 9, 1900.
New Mill Creek Drainage District	Atchison	October 12, 1900.
Levee District No. 1	Howard	May 2, 1901.
Cloverdale Drainage District	Buchanan	December 11, 1901.
Drainage District No. 1	Macon	December 16, 1904.
Des Moines & Mississippi River Levee District	Clark	January 19, 1904.
Chariton Drainage District No. 1	Macon	May 16, 1904.
Nodaway Drainage District No. 2	Andrew	December 10, 1904.
Chariton Drainage District No. 1	Macon	May 16, 1904.
Nodaway Drainage District No. 1	Holt	January 29, 1905.
One-Hundred-and-Two Drainage District No. 1	Nodaway	March 24, 1905.
North Nishnebotna Drainage District	Atchison	November 7, 1906.
Stewart Drainage District	New Madrid	December 3, 1906.
Mill Creek Drainage District No. 1	Holt	October 21, 1907.
Little River Drainage District	Butler	December 18, 1907.
Blackwater Drainage District No. 1	Johnson	May 22, 1908.
Little Tarkio Drainage District No. 1	Holt	October 1, 1908.
Grand River Drainage District Henry County	Henry	October 1, 1908.
Chariton Drainage Company	Schuyler	May 25, 1909.
Adair Drainage District	Adair	June 15, 1909.
Nodaway Drainage District No. 2	Nodaway	July 27, 1909.
Sambo Slough Levee District Carroll County	Carroll	September 10, 1909.
Sugar Tree Levee District Carroll County	Carroll	October 20, 1909.
Pioneer Drainage District Henry County	Henry	November 26, 1909.
Island Slough Levee District Carroll County	Carroll	December 16, 1909.
North Kansas City Levee District	Clay	December 11, 1909.
Levee District No. 2 of Howard County	Howard	January 24, 1910.
Big Tarkio Drainage District No. 2	Andrew	March 3, 1910.
Valley Drainage District	Shelby	March 21, 1911.
Fabius Drainage District	Marion	May 25, 1911.
Elsberry Drainage District	Lincoln	June 12, 1911.
Wyaconda Drainage District	Clark	June 20, 1911.
Malta Bend Drainage District	Saline	January 25, 1911.
Reinheart Drainage District	Schuyler	December 13, 1911.
Butler County Levee District	Butler	December 18, 1911.
Blue Bottom Levee District	Jackson	December 29, 1911.
St. John's Drainage and Levee District	New Madrid	March 29, 1912.
Fabius Drainage District No. 3	Knox	June 12, 1912.
Big Lake Drainage District	Scott	June 24, 1912.

MARK DRAINAGE DISTRICT
OF
MARION COUNTY MISSOURI

EDMUND T. PERKINS ENGINEERING CO.,
CHICAGO ILLINOIS.



THE MISSOURI DRAINAGE AND LEVEE ASSOCIATION.

The following call was the initiative in the organization of the Missouri Drainage and Levee Association at Jefferson City, Missouri, October 18, 1912, and the same is self-explantory:

"To All Persons Interested in the Reclamation of Missouri Swamp and Overflowed Lands:

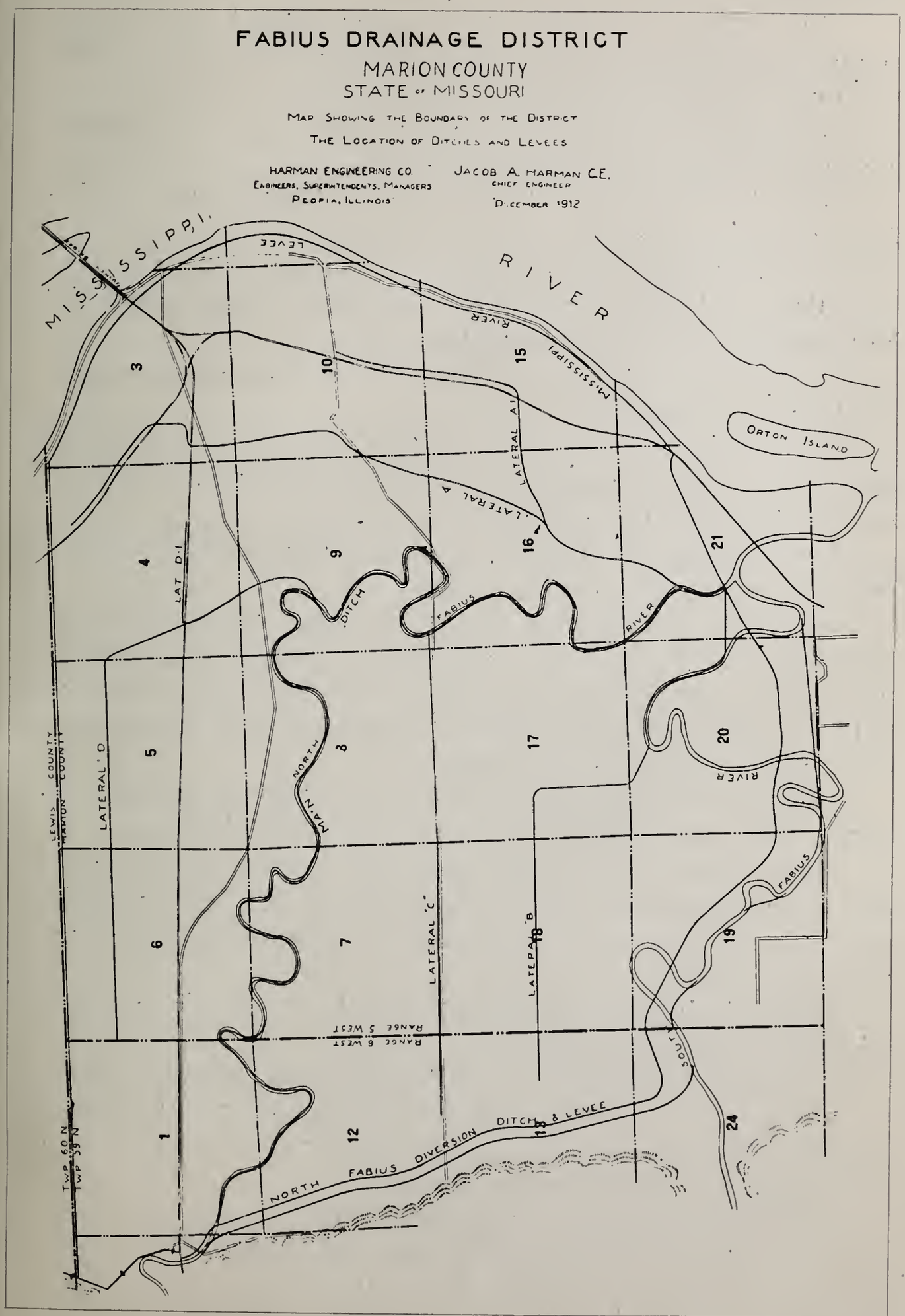
"At a recent meeting of the undersigned persons it was decided to issue a call for a conference of owners of swamp and overflowed land, attorneys familiar with the drainage and levee laws of this State, civil engineers experienced in drainage and levee work and all other persons interested in the subject of land reclamation by draining, leveeing or tiling, to be held at Jefferson City, Missouri, beginning at 2 o'clock p. m., October 18, and continuing through that and a part if not all of the next day.

"A program for the meeting is being prepared by this committee and all phases of land reclamation, such as the present Missouri laws and needed amendments thereto; construction work, engineering problems, land tiling and other questions will be discussed by the most competent men not only of Missouri but of other states. Already the committee has received assurances from eminent engineers of national reputation that they will be present and deliver addresses.

"The question of drainage and protecting the more than 4,000,000 acres swamp and overflowed land of this State is one of great importance and it should interest every loyal Missourian. If you own swamp land you should attend this conference and learn how to reclaim your property. If you are an attorney, and have had experience with the levee or drainage laws of this State, or are an engineer and have been engaged in land reclamation work, you should attend this conference and give us the benefit of your knowledge and experience.

"Maps of the various drainage districts in this State and models of dredging machinery will be displayed for the benefit and education of the persons attending. This will be one of the most important meetings ever held in Missouri and any one interested in land reclamation can afford to attend.

"If the persons attending this conference deem it advisable it is suggested by this committee that a permanent levee and drainage asso-


FABIUS DRAINAGE DISTRICT
MARION COUNTY
STATE OF MISSOURI
MAP SHOWING THE BOUNDARY OF THE DISTRICT
THE LOCATION OF DITCHES AND LEVEES
HARMAN ENGINEERING CO.
ENGINEERS, SUPERINTENDENTS, MANAGERS
PEORIA, ILLINOIS
JACOB A. HARMAN C.E.
CHIEF ENGINEER
DECEMBER 1912
MISSISSIPPI
RIVER
LEVEE
ORTON ISLAND
LATERAL A
LATERAL A1
LAT D-1
DITCH
FABIUS
RIVER
LEWIS COUNTY
MARION COUNTY
LATERAL D
NORTH MAIN
LATERAL C
LATERAL B
SOUTH
RANGE 6 WEST
RANGE 5 WEST
TWP 60 N
TWP 59 N
NORTH FABIUS DIVERSION DITCH & LEVEE
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ciation of this State be organized with the view of holding annual meetings hereafter for the discussion of reclamation and other questions.

"The railroads have been asked to grant reduced fares for this meeting, and the Jefferson City Commercial Club is preparing to make the visitors feel welcome while in the State Capital.

"For further particulars of this meeting and copies of the program write the chairman of this committee:

"John H. Nolen, Special Agent of State in Land Reclamation, Jefferson City, Mo., Chairman.

"Otto Kochtitzky, Civil Engineer, Cape Girardeau, Mo., Secretary.

"Edwin P. Deal, Chairman House Committee on Appropriations of Forty-sixth General Assembly, Charleston, Mo.

"Jewell Mayes, Secretary Missouri Valley Drainage Association, Ray County, Richmond, Mo."

The meeting was called to order by Otto Kochtitzky, who explained its purpose. Upon motion, Mr. Kochtitzky was made temporary chairman and John H. Nolen temporary secretary.

The committee had arranged an extensive program, which was, with one or two exceptions, carried out in full.

Committees on Resolutions and the Permanent Organization were appointed at the Friday session, and at the evening meeting submitted their reports. The former unanimously recommended that a permanent body to be known as "The Missouri Drainage and Levee Association," be organized. This report was adopted.

This committee also offered a draft of a constitution, which was accepted. (See copy of constitution at the end of these minutes.)

The Committee on Resolutions submitted a brief report which urged the coming Legislature to adopt such amendments to our present drainage and levee laws as would seem necessary in order to perfect and simplify these statutes.

Before adjourning on Saturday, October 19, the Association elected the following permanent officers:

President, Otto Kochtitzky, Civil Engineer, Cape Girardeau, Mo.

Secretary and Treasurer, J. H. Nolen, Special Agent of the State in Land Reclamation.

And three Vice-Presidents, as follows:

Hon. W. H. Richards, Attorney, Oregon, Mo.

S. T. Wilson, Capitalist and Merchant, Malta Bend.

E. C. Randolph, Civil Engineer, Caruthersville.

Some of the most important papers read at the first meeting of this association will be found immediately following these minutes.

CONSTITUTION OF MISSOURI DRAINAGE AND LEVEE ASSOCIATION.

Article I. The name of this organization shall be the "Missouri Drainage and Levee Association."

Article II. The purpose of this organization shall be to promote the reclamation of the wet and overflow lands of this State by educating the owners how to best reclaim the same; to improve the drainage and levee laws of Missouri, and to hold meetings for the discussion of subjects relating to land reclamation.

Article III. All owners of wet or overflow lands, engineers who have been or may hereafter be engaged in reclamation work, contractors engaged in construction work, purchasers and holders of drainage and levee bonds, all persons who have heretofore or may hereafter be employed as commissioners or viewers, and all attorneys who have been or may hereafter be employed in any manner in the organization of any drainage or levee district in the State, and all others interested in land reclamation, shall be eligible to membership in this association so long as such persons comply with all the provisions of this constitution.

Article IV. The right to vote or hold office in this association shall be limited to persons who are members in good standing, and all such members shall be entitled to receive copies of all printed reports and other matter issued by the association.

Article V. The officers of this association shall consist of a president, three vice-presidents, who shall reside in different parts of the State, and a secretary, who shall be ex officio treasurer of the organization. They shall be elected at the annual meeting of the association and hold office for one year or until their successors have been elected and duly qualified, and such officers shall constitute the executive board of the association in which the government of the organization shall be vested. The executive board shall have the power to arrange for the place and time of the annual meeting of the association, prepare the program for such meetings and perform all business of the association not otherwise provided for. Three members of the executive board shall constitute a quorum to transact business, and a proxy held at any meeting shall be considered the same as a member present.

Article VI. The president shall preside at all sessions of the association and shall be ex officio chairman of the executive board. In case the president be absent from any session of the association or meeting of the board, the first, second or third vice-president in regular succession shall act in his place. The secretary shall keep records of all proceedings of the association and meetings of the executive board, and shall render an account at each annual meeting of the money collected and expended.

Article VII. The association shall meet once each year, or oftener, at the call of the executive board. All meetings shall be held for the purpose of discussing topics relating to land reclamation and to transact such other business as may come before the association.

Article VIII. The association shall have the right, by a two-thirds vote of those present at any annual meeting, to amend or in any way change this constitution, and it may, by majority vote at any meeting, adopt rules to govern its procedure.

Article IX. The president, unless otherwise ordered by a majority vote of the association, shall appoint all special and standing committees. Of the former there shall be the following, composed of five members each: Membership, resolutions, nomination of permanent officers. A legislative committee, composed of five members, shall be appointed to draft such legislation as the association may indorse or the legislative committee may propose and present the same to the Legislature.

Article X. The association shall not indorse any special reclamation project, scheme or person, and political discussions and resolutions shall be barred at all times.

Article XI. The association shall have the right to levy an assessment not exceeding one dollar per annum on each member of the association to pay expenses incurred, and any persons refusing to pay such assessment shall forfeit his right to membership in and benefit of the association until such assessment shall have been paid.

THE IMPORTANCE OF SCIENTIFIC INVESTIGATIONS OF DRAINAGE PROJECTS.

By Edmund T. Perkins, Consulting Engineer, First Vice-President of National Drainage Congress, Chicago, Ill., Also Chief Engineer for Mark Drainage District, Marion County, Missouri.

Of recent years the reclamation of swamp and overflow lands has become a most important problem to a great many of our citizens, and rapid progress is being made in the dewatering of large tracts and their subsequent cultivation.

Not in all cases have these efforts at drainage been entirely success-

Edmund T. Perkins, Chicago, Ill.

ful, while in some cases the effort at reclamation has been an utter failure. In addition to the financial loss this has had a most unfortunate and depressing influence upon other persons who may have been considering reclamation work.

The main cause of these failures or partial failures is a lack of appreciation of the seriousness of the problem, and the attempt to reclaim and cultivate the land without proper knowledge of all aspects of the situation and without full scientific study and thorough preparation.

Need for drainage exists when water stands at or near the surface sufficiently long to make the soil soggy or compact by keeping the air from it and preventing or delaying the operations necessary to obtain a crop. Such needs are apt to exist when the soils are heavy clays either on the surface or as a subsoil, or are of other impervious material; and such conditions may exist upon high points or upon comparatively light slopes; but in general it is the low-lying, flat lands, with large contributing drainage areas and small outlets, that demand our attention.

No drainage project should be seriously considered until proper surveys and examinations have been made. Information should be secured concerning the lands which are to be reclaimed, the drainage area which empties its waters upon these lands, the amount of rainfall upon this drainage area, and the maximum run-off or depth of water that must be disposed of. This information is required so that we may determine whether or not the project is feasible, economical and profitable.

To obtain this information there should be made a complete map of the district, upon a scale sufficiently large to show all physical and human details. This map should show the differences in elevations, the courses of all streams, the swampy and low lying places, the hills and hollows, the cultivated fields, the forest areas, the areas covered with brush, all buildings, roads, bridges, railroads and other works of man. A map of this character would probably cost from twenty-five to thirty cents an acre. It would be used in all preliminary work in making "plans for drainage," and for making estimates of cost and in assessing benefits and awarding damages. In addition it would be available for all future time as a base map in extending drainage systems, either open ditch or tile, in building wagon roads, and in erecting telegraph, telephone or power lines. It would always remain an asset to the district.

This map, however, should not be made until preliminary investigations convince us that the project is in every way desirable. This preliminary investigation should cost from 7½ to 15 cents an acre.

Using this map, and knowing the amount of water that must be handled, we can accurately plan the necessary stream corrections, open ditches and the tile drains—balancing the value of the land against the

Indic

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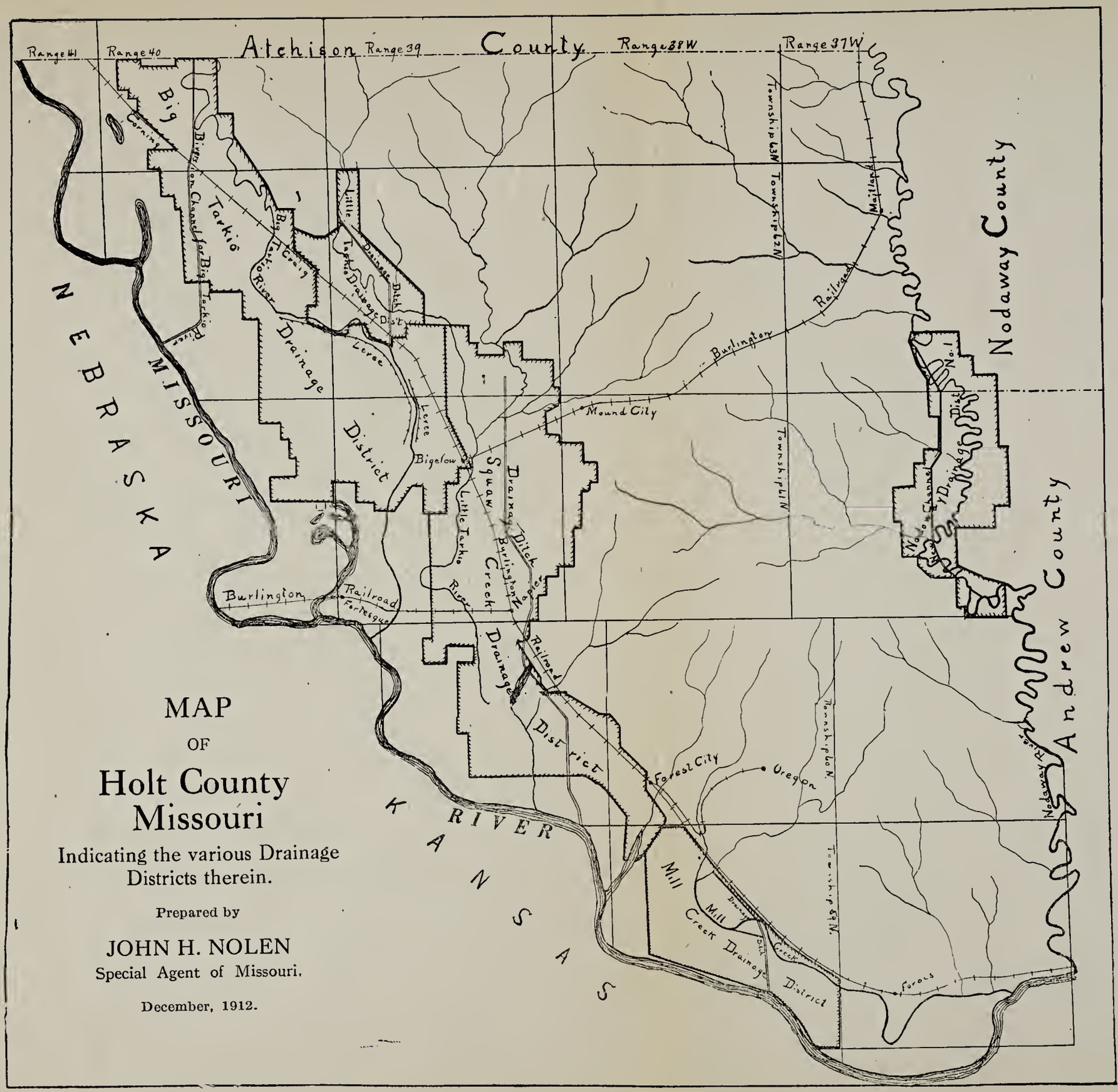

MAP
OF
Holt County Missouri

Indicating the various Drainage Districts therein.

Prepared by

JOHN H. NOLEN
Special Agent of Missouri.

December, 1912.

extra cost of tiling—and we can determine how most economically the surplus waters can be disposed of.

We must know that we can dispose of our surplus waters before we start the work. I have known of some cases where all plans were made for interior drainage, and after construction the project was a failure because there was no proper outlet provided for the final disposal of the water.

The location of the roads that the best service may be had with the least mileage is a special study and especially important is the convenient arrangement of open ditches and roads that the least number of bridges may serve to accommodate the neighborhood and through travel.

All of this planning for economical construction and maintenance of our interior work is as important as is the location and construction of the levees. It does not profit us if we protect our lands and then are unable to farm them.

If our levee is to keep out a stream we must be governed in our location by the height of the ground on which we build it, by the amount of timber and brush we have to clear away—since all timber, brush and roots must be removed—and especially is it necessary that there be sufficient "floodway" allowed outside the levee to make it certain that no flood will ever "top" it.

This question of flooding causes many mistakes to be made. It is only natural that no one wishes to leave good land outside the levee. Consequently levees have been built so close together, or so near the bluff or hill, that the flood could not be carried and consequent damage has resulted and additional expense incurred for raising or strengthening the levees.

Again, the character of the soil that is to form the base of the levee, or that is to be used for building the levee, must be considered carefully in making our location; the height, width and slope of the levee must all be balanced in relation to the work that the levee must do; for it must not be too heavy in section so as to be extravagantly expensive, nor can it be too economically light so as to fail; and it must be so located on the stream bank as to be free from danger of being undermined.

Having built our levees to keep out the flood waters, and our open and tile ditches to relieve the lands, we must provide an adequate outlet for the rainfall, seepage and hill waters, either by gravity or by pumping.

As much hill water as possible should be diverted outside the levee, for not only is it expensive to get rid of the water, but the silt, mud and debris washed down from the hills onto the lowlands are a continual

source of serious trouble and will continue to be until our farmers learn how to farm as the southerners are doing, and preserve their soils.

In most cases, and this is especially true of small projects, pumping will be necessary and advisable. Here is where knowledge and the right experience are most necessary; the knowledge and experience, not of the man selling pump equipment, but of some one in the employ of the farmer. The type of machinery to be used, the power and the size, all must be carefully investigated in order that economical and efficient dewatering can be done.

A few days since a project was inspected where a ten thousand dollar plant had been erected on a foundation heavy enough and expensive enough to carry a thirty thousand dollar plant.

And so it goes all along the line. Every day the importance of full and thorough scientific investigation of all drainage projects before construction starts is emphasized. The present most disheartening feature of reclamation is the failures or the semi-failures of projects which have not been so investigated.

LAND RECLAMATION FROM CONTRACTOR'S STANDPOINT.

By Otto Kochtitzky, Civil Engineer and Chief Engineer, of the Little River Drainage District, Cape Girardeau, Mo.

The development and perfecting of the dipper dredge from a small machine with a half-yard dipper which was moved by dragging it on the bottom of the ditch, to the 100 horse-power floating drege carrying a dipper of five-yard capacity on a boom eighty feet long, has greatly modified the ditch digging problem. The large machine is operated by the same number of men and about the same expense except some increase of fuel and a greater initial cost.

I would illustrate this with four ditches each twenty miles long, located in timber district, with top widths respectively 20, 25, 30 and 40 feet, and all eight feet deep. This work, if located in Southeast Missouri, would be done at the following prices, and each job give the contractor a reasonable profit.

Width of top of ditch.	Width of hull required.	Size of dipper.	Cubic yards per mile.	Price per yard.	Clearing cost per mile.	Total cost.
20 feet.....	18 feet.....	1 yard....	18,773	8c	$200	$34,037
25 feet.....	22 feet.....	2 yards...	26,788	6½c	200	38,825
30 feet.....	25 feet.....	3 yards...	34,717	5½c	200	42,189
40 feet.....	35 feet.....	5 yards...	50,062	4½c	200	49,054

The cost of a job includes five items—clearing, installation, excavation, deterioration and profit.

Thus, on the second job above described:

The clearing cost is.....	$3,400
The installation cost is.....	6,000
The excavation cost is.....	20,000
The deterioration.....	2,000
The profit.....	7,425

These prices are not often obtained and are given as for ideal conditions, but can be fairly used as an illustration of my argument. Engineers frequently lose sight of the contractor's view of dredge work. We

Otto Kochtitzky, Cape Girardeau, Mo., pioneer drainage engineer and president of the Missouri Drainage and Levee Association.

have examples of "eight cents per yard plus cost of clearing" on jobs so small that the total estimated cost would amount to little more than the cost of installing the machine and clearing the line.

Thus it will be seen that the larger ditch may be secured for little extra cost. This applies to depth as well as width, and in material where there is reasonable promise of stable banks such depth should be made as will allow for the inevitable filling at the bottom from sloughing of sides and still leave the serviceable ditch. The construction disturbs the earth at the sides by tearing out the tree roots, and the upward lift of the big dipper also tends to break up the earth. The ditch banks become fairly established after about two years, although nature by the action of rain, frost, vegetation growth, etc., continues her leveling process forever. In the softer soils, and in sandy bottoms, especially in timber districts, it is not reasonable to expect the banks to stand up well and the better practice would be to construct a wider ditch at first instance, with berms about 15 feet wide, contemplating cleanout work after two or three years when the disturbed earth has become compacted and there is better promise of permanency of banks.

The owners of wet lands contemplate ditching as a means of removing surface water; the competent drainage engineer should plan to accomplish more than this. He should insist upon ditches which will afford outlet for under drainage to such extent that the line of "ground water" (the water bed in the land) is not less than three feet below the surface.

The difference between profit and loss is but a small per cent of the total investment in any line of business. It costs more to farm wet land than dry land. When you decide to undertake to reclaim wet land, make the resolution to do a good job; *make it dry like upland*... Keep your mind upon the value of that rich bottom when perfectly reclaimed, secure a competent engineer and do good work. This pays, and it is the only character of reclamation work that really does pay what it should. The effort necessary to grow 30 bushels of poor corn on an acre of wet land should just as well secure 60 bushels of good hard corn on the same acre properly drained.

THE MISSOURI RIVER VALLEY DRAINAGE PROBLEMS.

The Reclamation of Lands in the Missouri River Valley North and East of Kansas City—The Engineering Problems Encountered and Their Solution—Address of C. E. Jacoby, Engineer of Kansas City.

In the engineering profession the control of water is one of the great problems that has confronted man from the time of Noah to the present day. In fact, one good criterion of the advancement of a country is seen in the development and control of waterways and sources of water supply.

Clark E. Jacoby, C. E., Kansas City, Mo.

With the increase of civilization and the massing of large populations in cities, the question of an adequate and pure water supply to meet the needs of the people is one that has claimed the special attention of a large branch of the engineering profession.

The problem of water in its relation to land reclamation for agricultural purposes is an old one; but in this country until recent years it has not been given much attention. Ancient Egypt was the most enlightened nation of its time and some of the engineering feats of the early dynasties have endured through the centuries as a monument to the

greatness of that period, but one of the most practical and beneficial was the development of the system of control of the waters of the Nile which so enriched the valley that it became the granary of the then known world.

In the United States up until a comparatively short time ago there was an abundance of good fertile farm land at a moderate price and there was no necessity to consider the reclamation of the waste swamp and overflow land; but with the increasing land values attention has been directed to the only cheap land remaining and in the states east and north of Missouri much progress has been made in the reclamation of the swamp and overflow lands with such results that the reclaimed lands are the most productive in the territory.

This doctrine of land reclamation is moving westward and Missouri is the next state in its line of progress. Already Missouri is beginning to wake up to the opportunities for development on this line as is evidenced by this conference.

The engineering problems that are presented in land reclamation in Missouri are as varied as they are interesting; the soils vary from the loose sandy loam to the black sticky gumbo, the valleys vary from one to fifteen miles in width and the fall varies from less than one foot to the mile to as high as ten feet to the mile. It may not seem possible that there are valleys one mile in width with a natural slope of ten feet to the mile that are subject to frequent and destructiv overflows; but nevertheless this statement is true.

There are many valleys in our State from 30 to 75 miles in length and from one to two miles in width, which have an average fall of from 2½ to 4 feet to the mile. The soil usually varies from sandy or light alluvial loam at the upper end of the valley to the heavy gumbo which is more prominent in the lower portions. On either side of the valley the hill or uplands rise abruptly from the level bottoms. The problems connected with the ultimate reclamation of overflowed lands of this character have been before us for some time, but until recently very little serious thought has been given in trying to work out practical solutions. Examples of this class of work may be found in Big Creek valley, Carroll county; Locust Creek valley, Linn and Sullivan counties; North Grand river, South Grand river and Big Creek valley in Cass, Johnson and Henry counties. Four drainage districts have been organized in these valeys and four more are in the process of organization.

However, I believe it was suggested by the committee who arranged for this conference that I outline the work being done and speak more particularly concerning the problems presented in the reclamation of

lands lying adjacent to the Missouri river north and east of Kansas City, and more particularly in Ray and Carroll counties. In these counties there is a total of about 220 square miles of bottom lands lying in the valley of the Missouri river. This is the largest body of bottom land between Kansas City and St. Louis lying between points where the bluffs touch to the banks of the river.

The engineering problems encountered in connection with the reclamation work in this section of the Missouri river valley may be divided into four general heads, viz.:

1st. The prevention of injury by floods from the Missouri river.

2nd. The prevention of injury by floods from tributary streams of the Missouri river.

3rd. The prevention of injury from hill waters.

4th. The provision for adequate surface and underground drainage.

I have endeavored to name these in the order in which, as a general rule, the work should be taken up and carried out. Before costly drainage and tiling systems are established the flood waters of the Missouri must be confined to a permanent and well defined chanel. To do this it is necessary to first revet the banks of the river, and, second, construct adequate levees. The shore line of the Missouri is continually changing and shifting; as a general rule the upper side of the large bends are cutting and the lower portions filling. The rich sandy loam soil of the valley melts like sugar before the erosive action of the waves. At the present time levees constructed along the Missouri river give only temporary relief and cannot be called permanent improvements. While it is true that there are portions of the valley so located and of such elevation that they are not materialy affected by the overflow conditions of the Missouri and can to a certain extent be improved by ditches and drains yet the greater portion of the lands must be first protected from Missouri's flood waters before other intricate and more costly schemes are employed.

After the revetment work and the construction of levees the next step in the work of reclaiming these lands is to prevent injury by floods from tributary streams. Often these tributary streams will cause very disastrous floods, destroying thousands of acres of crops lying near the junction of the two valleys. These flood conditions must be relieved by straightening the channels, building by levees, or by a system of diversion ditches, or, perhaps, a combination of these methods.

The prevention of injury by floods from hillwaters is almost as important as the preceding problem of injury from tributary streams. That portion of the valley situated at or near the base of the bluffs, where small branches and rivulets come down from the hills, is either subject to

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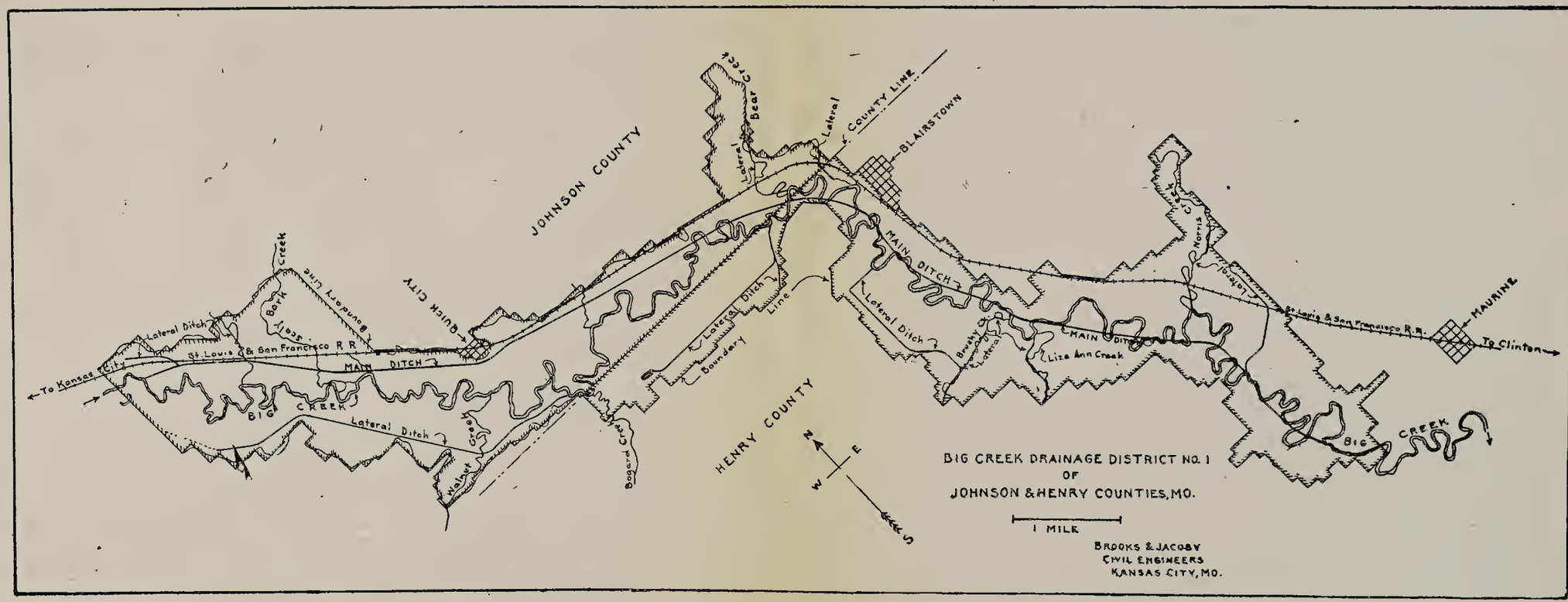

JOHNSON COUNTY
HENRY COUNTY
Bear Creek
Lateral
COUNTY LINE
BLAIRSTOWN
Bark Creek
Lateral Ditch
Boundary Line
St. Louis & San Francisco R.R.
MAIN DITCH
To Kansas City
BIG CREEK
Lateral Ditch
Walnut Creek
Bogard Creek
GUILFORD CITY
Lateral Ditch
Line
Boundary
Lateral Ditch
MAIN DITCH
Brushy Creek
Lateral
Lize Ann Creek
Norris Creek
Lateral
St. Louis & San Francisco R.R.
MAURINE
To Clinton
BIG CREEK
N
W
E
S
BIG CREEK DRAINAGE DISTRICT NO. 1
OF
JOHNSON & HENRY COUNTIES, MO.
1 MILE
BROOKS & JACOBY
CIVIL ENGINEERS
KANSAS CITY, MO.

frequent overflow which renders profitable cultivation impossible or it is covered with ponds and swamps. These ponds are cesspools of malaria, breeders of flies, mosquitoes and a menace to the development of the surrounding territory. Large ditches designed with proper cross section and grade, if constructed and maintained, extending from the foot of the bluffs to the Missouri river or tributary streams would in most cases be adequate to reclaim these lands. The more practical route for most of these ditches would be to the Missouri river were it not for the fact that the river is not revetted and therefore it is impossible to maintain permanent levees, flood-gates and pumping stations. These levees and floodgates are necessary for the reason that the bottom lands lying to the north and east of the Missouri river are usually lower than the lands near the river, and in cutting these open ditches through the higher ground, only increases the danger of floodwaters from the Missouri river backing up the ditch and overflowing the very lands that are sought to be drained. So that diversion channels and drainage ditches as a rule should not be drained into the Missouri river until the permanent shore line is established and until this work is taken up and executed by the government the reclamation work along the valley will be greatly impeded.

Provisions for adequate surface and underground drainage must be made in most portions of the valley before full benefits can be obtained. Fully 50 per cent of the Missouri river valley needs tiling, and in order to do this large drainage ditches must be constructed for outlets. Here again we are at a loss to know where to give these ditches an outlet—for a network of ditches and tiling connecting with the Missouri river without proper flood-gates, cutoff valves, reservoirs and pumping plants would not be practical; but in my opinion would have a tendency to raise the water level in the lands sought to be drained rather than lower it. Costly floodgates, reservoirs or pumping plants established near the caving banks of the river would be very unwise and impractical, so that this work must also of necessity, for the most part, wait for the completion of the establishment of a permanent shore line along the Missouri river and the construction of levees.

Thus it is clearly shown that the reclamation of these lands must begin with improvements on the Missouri river itself.

In Ray and Carroll counties there are approximately 220 square miles of rich alluvial bottom lands which, if properly protected, would be worth on an average at least $150.00 per acre, or an aggregate of $19,200,000, an amount equal to the sum of the assessed valuation of the whole of the two counties in which these bottom lands are situated.

If the Missouri river were situated in the eastern part of our coun-

try it would be the pride of the land instead of a menace to the country through which it passes, a highway of navigation and commerce instead of a desolate picture of sandbars, islands and caving banks. The people of this section are earnestly demanding that the government aid them now in this great work, and the landowners are ready and willing to do their part, as will be evidenced by the following report of work that has been completed and the work now under construction.

Although there are portions of the levees that are undermined and carried away from year to year, yet with that sturdy pioneer spirit the landowners in the valley have constructed and are attempting to maintain over twenty-six miles of levees. In the present year about four miles of good, substantial levees have been washed away into the river by undermining and caving banks; notwithstanding the fact that when constructed these levees were from one-fourth to one-half mile from the caving banks. The present levee system is adequate so long as they are not undermined, to protect about forty-three square miles of land.

In the work of drainage the landowners have not been idle, but have organized districts wherever practical, and in some instances the ultimate success of the projects will be curtailed until the river front is improved. Already twenty-six miles of main drainage ditches have been constructed and forty-eight miles of lateral ditches, and there are now under construction twenty-one miles of main drainage ditches and fifteen miles of lateral ditches, and five and one-fourth miles of main ditch and five and three-tenths miles of laterals ready to let contracts, making a total of 160 miles of ditches, necessitating the excavation of 5,000,000 cubic yards of earth. One hundred and sixty-five square miles of land are included within the boundaries of the benefit districts taxed to pay for these improvements. The total amount of drainage and levee work completed, under construction and assured up to the present time in these two counties, represents an expenditure of $460,905.00.

The names of the districts, acreage and brief outline of the work and some estimates of benefits derived are herewith shown in the table.

The table herewith shows that for $121,000.00 spent for drainage work already completed the districts have received in return $1,442,500.00 in increased value of lands—an average increase of $58.00 per acre, and for every dollars spent $12.00 in return. The average yield of crops has also been increased 75 per cent, which alone in two years' time would more than pay for the improvements.

The current table also shows that the $66,405.00 spent for levees has actually saved $654,000.00 worth of crops, and the construction and maintenance of the levees has added $1,280,625.00 to the value of the

lands in the districts, or nearly $45 to the acre, and for every dollar spent $29.00 has been received in return, or for the three years every dollar spent for levees has netted 960 per cent interest on the investment. And when these levees are made permanent add to the named benefits the feeling of security created among the landowners, the more efficient methods of farming employed, the better class of tenants introduced and the increased taxable wealth of the community, and we begin to measure the full value and benefit of what reclamation work in the Missouri valley means. The landowners along the Missouri river are rapidly awakening to these facts and the greater number of them are now ready, anxious and willing to go ahead with this work as soon as a proper shore line can be established and maintained.

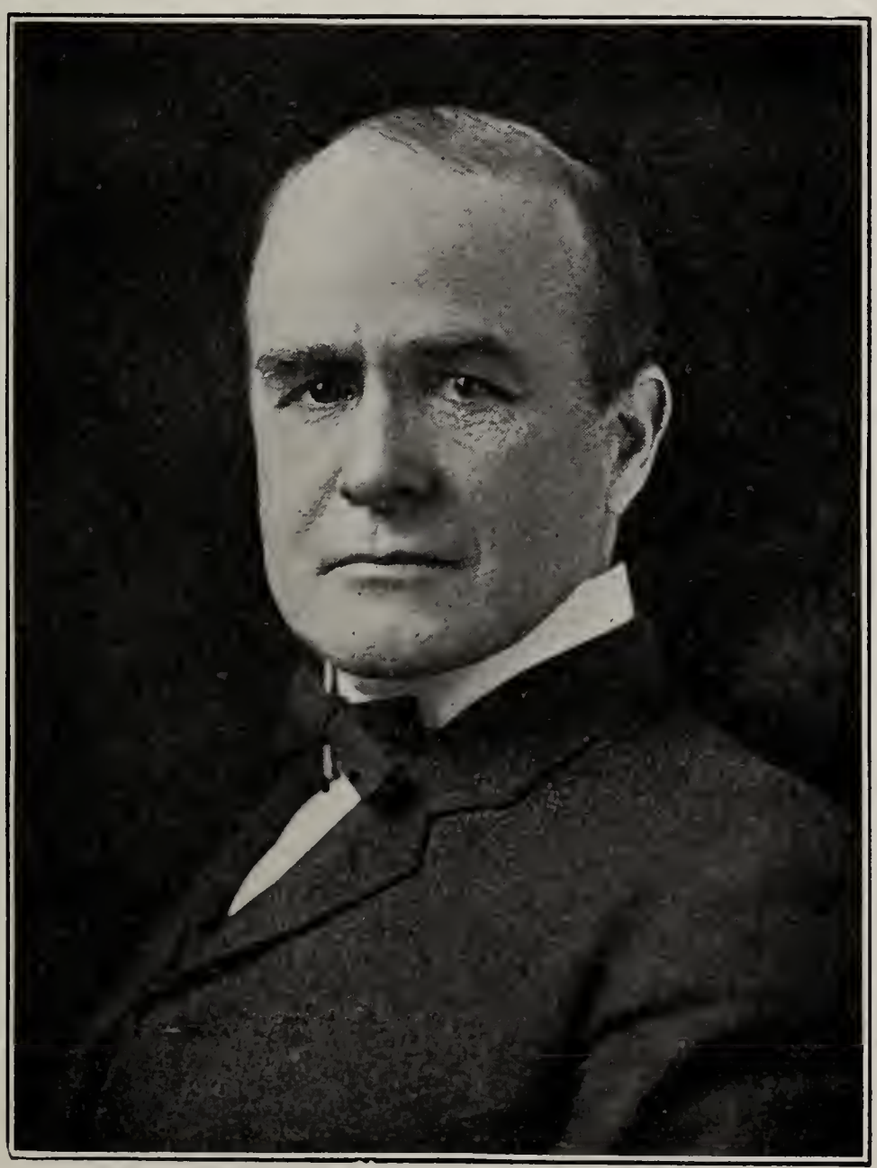
Boys take pride in growing corn on redrained land.

Name of Improvement	Year organized	Acres	Work completed	Cost of Work	IMPROVEMENT						Cost per cubic yard	Value of Land Per acre		Value Crops Saved	Percent increase in crops in any one yr.	Per cent in cultivation	
					Main ditch		Laterals		Levees								
					Length	Size	Length	Size	Length	Size		Before	Now			Before	Now
Norborne Drainage District Carroll County ½ Ray ½	1900	14,400	1904	$ 65,000	12 miles	20 ft. base	35 miles	.....	.....	.....	7c 12½, 18	15.00	100.00	.....	80%	20%	80%
Sugar Tree Drainage District	1906	6,500	1910	34,000	7 miles	10 ft. base	8 miles	6 ft. base	.....	.....	3⅓e	30.00 75.00	55.00 115.00	.....	33⅓%	60%	100%
Sugar Tree Levee District	1908	4,000	1909	4,000	.....	.....	.....	.5 ft. base	1½ miles	12 ft. crown	13c 17e	50.00 75.00	75.00 100.00	1909 $84,000	.....	.....	.....
Island Slough Levee District	1909	1,000	1911	8,900	.....	.....	.....	.....	4½ miles	6 ft. crown	10c	20.00 60.00	50.00 100.00	2 yrs. 20,000	.....	.....	.....
Sambo Slough Levee District	1909	11,000	1910 1912	8,200 7,000	.....	.....	.....	.....	7 miles	12 ft. crown	10e 14e	50.00 100.00	75.00 150.00	300,000 100,000	.....	.....	.....
Miami Levee and Drainage District	1909	2,000	1910	5,000 4,000	2½ miles	4 ft. 12 in.	.....	.....	2 miles	8 ft. crown	.....	65.00 80.00	75.00 95.00	.....	75 to 90%	.....	.....
Drainage District No. 3 Carroll County	1906	70,000	.....	235,000	21 miles	50 ft. base	15 miles	.....	½ mile	.....	7.4e 8.7c	.....	.....	.....	.....	.....	.....
Willow Drainage District Ray County	1909	1,900	1911	17,000	3 miles	20 ft. base	5 miles	15 ft. base	.....	.....	11e	6.00 30.00	50.00 75.00	.....	40%	.....	.....
Levee District No. 1 Ray County	1909	2,845	1909	9,825	.....	.....	.....	.....	1¾ miles	8 ft. crown	9¾e	40.00 65.00	75.00 100.00	30,000	50%	.....	.....
Levee District No. 2 Ray County	1910	2,580	1911	15,480	.....	.....	.....	.....	6¼ miles	8 ft. crown	10¾e	40.00	75.00	40,000	50%	.....	.....
Levee District No. 3 Ray County	1910	5,320	1910	9,000	.....	.....	.....	.....	1¼ miles	8 ft. crown	10¾e	15,00	75.00	80,000	90%	.....	.....
Crooked River Drainage District	1912	5,460	.....	38,500	5¼ miles	12 ft. base	5.3 miles	5 ft. base	.....	.....	.....	.....	.....	.....	.....	.....	.....

GREAT LAND MOVEMENTS OF THE UNITED STATES.

By Lester Shepherd Parker, Capitalist, Jefferson City, Mo.

I feel that my remarks on this occasion will be from a different viewpoint than those already presented, for I have listened to the most able presentation of the legal problems involved in the proceedings necessary to reclamation of swamp lands, and to equally edifying and important addresses of the civil engineers dealing with the physical



Lester S. Parker, capitalist, Jefferson City, Mo.

phases. My deep interest in this question has not been along these lines, but in land as the greatest of all investments. For over thirty years I have made a close study of this feature of the problem and wish to present to this convention the great land movements of the United States and the bearing they have had upon your commendable work.

THE FIRST IMPORTANT LAND MOVEMENT

Of this country occurred immediately after the Civil War. It was sweeping in its action, heeding the admonition of Horace Greeley to "Go West." Great swarms went out to possess the rich open prairie lands of Kansas and Nebraska. This migration lasted without intermission for fifteen years, homeseekers covering that part of this country under the homestead and pre-emption laws.

THE SECOND GREAT MOVEMENT

Took place in the early eighties, when Villard completed the Northern Pacific that opened up the fertile valleys and prairies of Minnesota and the Dakotas. As the demand for land grew more intense the great Northern railroad was projected through the country so far north that many of the conservative people predicted failure from an agricultural standpoint by reason of its high latitude. This project succeeded, however, and when completed did not appease the growing demand for land, so

THE THIRD MOVEMENT

Started and it extended up into the Manitoba country through which the greatest transportation system of the world, known as the Canadian Pacific, was projected under the stupendous subsidy of the Canadian Government. This remarkable line of railroad was completed from ocean to ocean, running through the open prairies of Alberta and opened up all of the land in that part of Canada subject to rainfall and practical farming. The lust for land continued still more intense than ever and

THE NEXT MOVEMENT

Was directed to the arid lands of the west subject to irrigation. The amount of money expended in this movement for the reclamation of this class of lands has been fabulous and is being pushed today in every locality in almost every altitude even up to 7,000 feet where water can be stored and used for agricultural purposes. At the commencement of the twentieth century

THE NEXT MOVEMENT

Was a campaign into the immense state of Texas where the ranch owners were forced by attractive offers per acre, to cut up their ranges for the benefit of settlers. Four years ago where the cactus and mesquite areas only supported one steer to ten acres, are now found prosperous towns and railroads, even though they have had to dig artesian wells for water with which to irrigate the lands.

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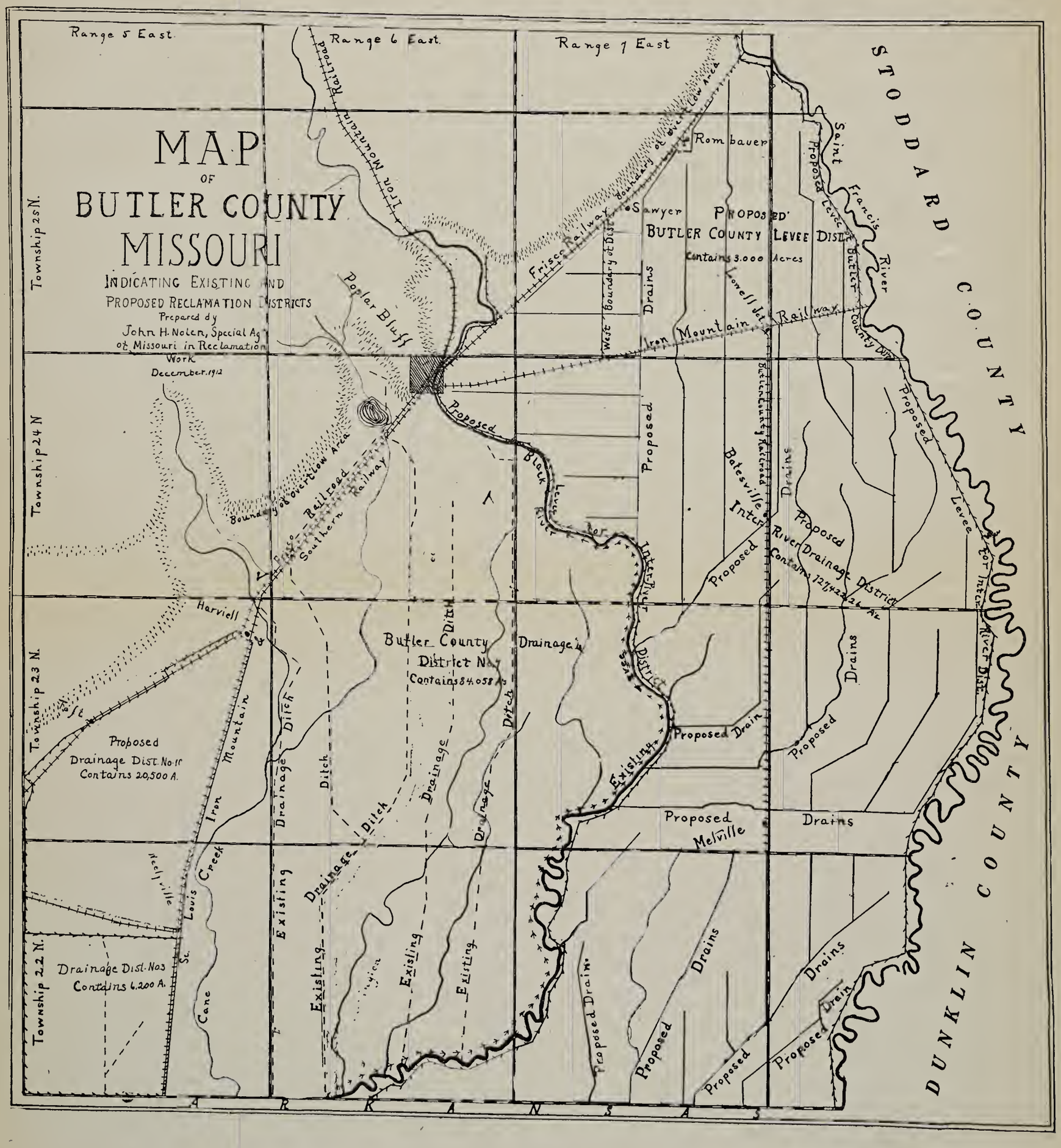

MAP
OF
BUTLER COUNTY
MISSOURI
INDICATING EXISTING AND
PROPOSED RECLAMATION DISTRICTS
Prepared by
John H. Nolen, Special Ag't
of Missouri in Reclamation
Work
December. 1912
Range 5 East
Range 6 East
Range 7 East
Township 25 N.
Township 24 N
Township 23 N.
Township 22 N.
Iron Mountain Railroad
Poplar Bluff
Frisco Railway
West Boundary of Drainage District
Low Area
Rombauer
Sawyer
Saint Francis River
Proposed Levee
Butler County Ditch
PROPOSED
BUTLER COUNTY LEVEE DIST
Contains 3.000 Acres
Drains
Lowell Ditch
Iron Mountain Railway
Proposed
Black River
Levee
Boundary of Overflow Area
Frisco Railroad
Southern Railway
Batesville Interurban
Butler County Railroad
Proposed
Levee
For Intercepting
River Dist.
Proposed
River Drainage District
Contains 127,424.24 Ac.
Harviell
Butler County
Drainage
District No 1
Contains 84,058 Acs
Proposed Drain
Existing
Proposed
Drains
Proposed
Drainage Dist. No 1?
Contains 20,500 A.
Iron Mountain
Drainage Ditch
Existing
Drainage Ditch
Melville
Proposed
Melville
Drains
St. Louis
Cane
Drainage Dist. No 3
Contains 6,200 A.
Existing
Drainage Ditch
Existing
Drainage Ditch
Existing
Drainage Ditch
Proposed Drain
Proposed
Drains
Proposed
Proposed
Proposed Drain
Proposed
Drains
STODDARD COUNTY
DUNKLIN COUNTY
ARKANSAS

I have traveled about much for the purpose of watching these pageants of land hunters, deeply interested by some of the following observations. Last year I discovered in riding through the Saskatchewan, Canada, over the Canadian Pacific, the 26th of August, that the people were fearful of the frost interfering with their wheat, and they were cutting many fields before the grain was hardly in the milk, to save it.

The wheat harvest was enormous where five years ago agriculturists stated it was almost impossible to grow crops profitable on account of the frost, which often hangs on until the first of June and sweeps down before the first of September. In spite of this drawback, land twenty miles from the railroad is now selling for $9.00 an acre, and during the last four years towns like Moose Jaw and Calgary have doubled in population. Imagine my surprise when I discovered a new road being projected five hundred miles north of the Canadian Pacific, called the Prince Rupert road, built for no other purpose than to satisfy the appetites of the land-hungry population in this country.

In 1900 many Illinois farmers sold their land for $100 an acre and moved into Missouri and bought choice farms at $60.00. In four years this land was selling at $100, but the Illinois land which they had left increased to $150.

Irrigated land in the west, even though far distant from good markets, is selling from $100 to $1,000 an acre. Raw Texas land before mentioned, upon which cactus must be cleared and a well dug for irrigation, sells today from $30 to $60 an acre.

From these observations, who can deny the unparalleled opportunity for investment in the unreclaimed wet lands of the Mississippi valley which can be purchased at prices ranging from $8 to $15 per acre?

THE NEXT GREAT MOVEMENT

Will be to the undrained lands of the Mississippi valley which are the richest in the world and which have been overlooked. The people are just beginning to realize the possibilities of this area, and the last of these great movements will sweep it up, leaving no more land to induce immigration as we have described. Consider that all this alluvial unreclaimed land is right at the doors of the great markethouse of this country. It offers the greatest inducements ever presented for money-making.

The railroad arteries since the birth of the United States have been extending from east to west, but the Panama Canal will soon start longitudinal systems which will accentuate the land values in this rich

Mississippi valley beyond computation. It is destined from the influence of these new systems to be the center of the densest population, and with improvement in sanitation, which is rapidly being brought about, the delightful climate of the southernmost part will not be ignored.

I recommend that the State of Missouri institute a department of drainage under a competent commissioner, and that all the states of this great valley bring such pressure to bear upon the Federal Government that all the drainage systems may be connected and unified in plan and purpose.

I recommend that the drainage laws be so codified as to give uniformity and to cover satisfactorily constitutional questions of service, property rights, etc. I recommend that the congressmen of these central states be impressed with the fact that the people in the interior need land and not battleships, and that it is high time some definite Federal encouragement be given to this great swamp land reclamation movement.

Orchard in a reclaimed district.

FARM UNDER DRAINAGE.

(The under-drainage of land by the use of tiles has been neglected in Missouri, except in a very few localities. This State has between ten and twelve million acres of land that is in need of this character of drainage, and in order to arouse sentiment in favor of this work and impart information pertaining thereto, the author of this report deemed it advisable to devote a chapter to this subject. Mr. Charles G. Elliott, Consulting Engineer, Washington, D. C., the author of this article, has devoted many years' study to this question; he has written a number of books on the subject and is recognized as being one of the leading experts in America on under-drainage of land. It is believed his production will stimulate the movement in Missouri and result in great good.)

Much experimental and scientific effort is now exerted for the purpose of advancing agriculture and bettering the financial and social conditions of the farmer. In reviewing the trend of these activities among scientific investigators and intelligent agriculturists generally, I have been of the opinion for some time that the importance of securing proper moisture conditions of the soil, is too frequently overlooked. Emphasis is attached to variety and vitality of seed, method of planting, fertilizing, rotation, cultivation and harvesting, but the moisture conditions of the soil and subsoil are too often left undisturbed without any effort on the part of the farmer to modify or control them.

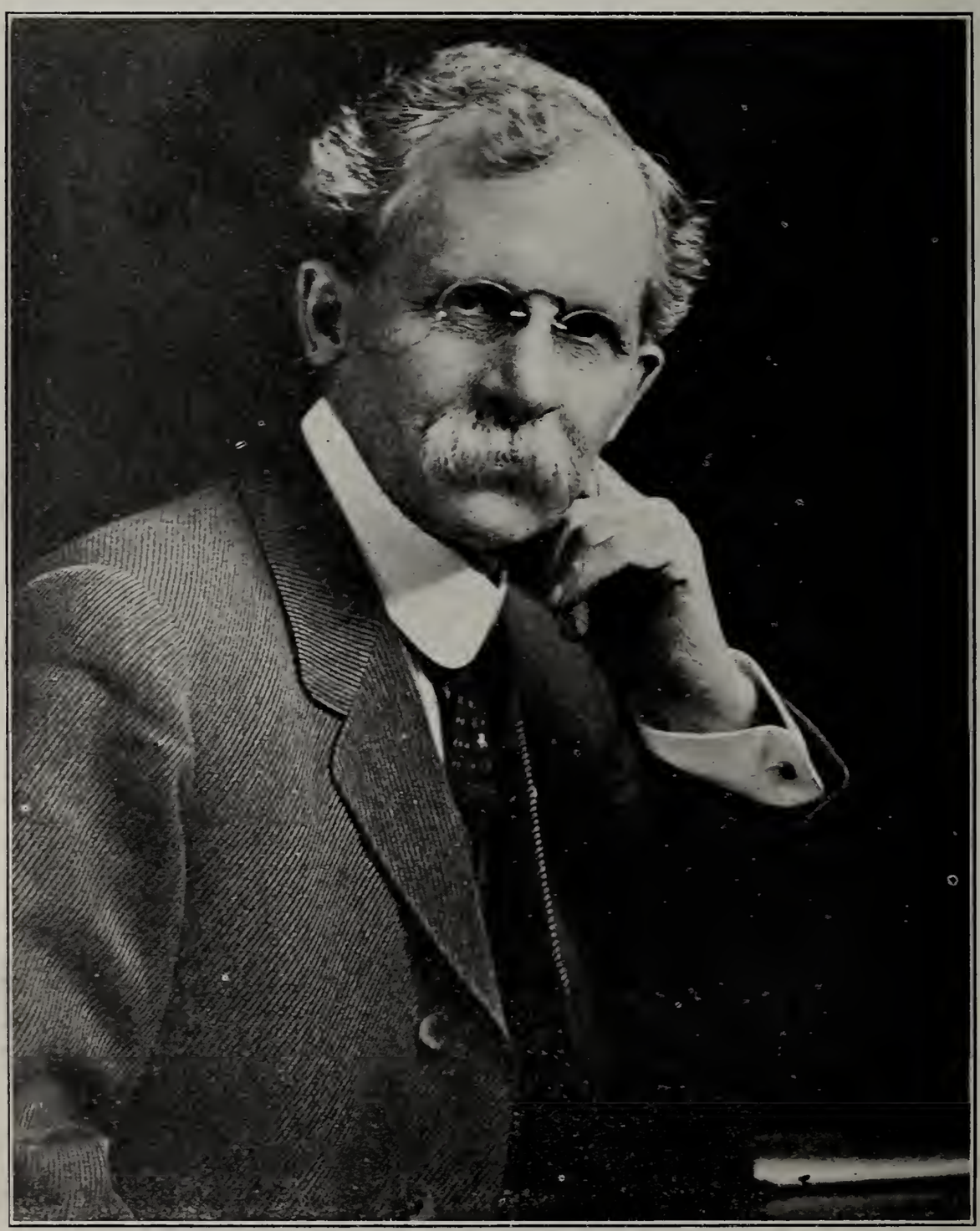
While there is no occupation so much subject to the weather as agriculture, yet nothing is so well calculated to counteract the adverse effects of weather upon the farmer's growing crops or ameliorate unfavorable conditions of the soil as underdrainage. It increases its capacity for storing water which is needed in the dry season as well as removes the surplus during a wet time. It fits the soil for planting earlier in the spring and by increasing its porosity and tilth throughout, extends and widens the range of feeding surface for plants; the plant is not subject to backsets whenever an excess of rain occurs, for while untoward weather may retard the top growth for a few days, the roots being in healthful surroundings, gather strength so that the plant shoots forth with renewed vigor as soon as sunshine and warmth return. Crops are less subject to ravages of disease and insects if the soil is in condition made possible by good underdrainage for timely and thorough cultivation.

LAND REQUIRING UNDERDRAINAGE.

It is not my intention to explain or even name the many virtues of

underdrainage when applied to soils which are periodically too wet for farm crops. I shall assume, rather, that the superiority of well-drained land is acknowledged but not fully appreciated, and that the method of securing it is not understood.

Few farms in the State are free from wet fields or from land at least which is left waste because it is too wet for profitable use. I ven-



Charles G. Elliott, C. E., consulting drainage engineer, Washington, D. C., formerly Chief of Drainage Investigation of Federal Department of Agriculture.

ture the assertion that many so-called naturally drained fields would be greatly benefited by underdrainage. It has come to my attention that many fields in the eastern states which have been farmed for a hundred years are in a chronic state of wetness and must be drained before the land can be renovated by modern methods.

The fact that land is rolling and diversified in surface contour does not necessarily obviate the necessity of artificial drainage. The value of tile drainage in the country was first shown near the banks of Senaca Lake, New York, on clay land which was rolling and pleasing to the view. For seventy years these lands have grown large and continuous crops. Notwithstanding this and other examples, the practice of underdraining in western New York languished, until a recent revival is now bringing marked benefits to many sections of the State.

METHODS SHOULD BE ADAPTED TO CONDITIONS OF SOIL.

The effectiveness of underdrains depend upon the adaption of plans and methods to the character of the soil to be treated. This principle cannot be too strongly emphasized. Close or dense soils of which stiff clay, black gumbo, buck shot and hardpan, are well recognized varieties, do not permit water to percolate through them easily. They are finely commuted, that is, the particles composing them are exceedingly small and not separated by sand or coarser vegetable substances, lacking which they make a compact body, hard when dry and a waxey mass if they are manipulated when wet. While many soils of this description are inherently fertile, they are disappointing when the attempt is made to farm them, mainly because of the difficulty in keeping them in a properly drained and tillable condition. When exposed to the atmosphere, the action of the sun, moisture and temperature change their physical character and they become loose, friable and easily cultivated as long as that condition can be maintained. On the other hand, if they are handled while wet, they become plastic and form a water-tight mass. The tread of an animal or the wheels of a moving vehicle puddle the surface until the depressions so made retain water which happens to fall into them until it passes away as atmospheric vapor. Under these conditions it is not surprising that such soils are often pronounced undrainable and useless.

In their natural condition they are impervious, only when compared with more open soils. It will be noted that after passing through a dry season they become saturated to a considerable depth within a short time after continuous rains begin. They are wet by rain which percolates through them slowly. If a dry pit is dug in such soil, it fills slowly with water when the ground becomes wet. If a subsoil, which is close in general structure, contains pockets and irregular strata of more permeable earth, which is not infrequently the case, the movement of soil water is greatly facilitated.

Coming now to their practical drainage, I observe first that under-

drains should be placed at a less depth in such soils than in the more open ones. The teaching that underdrains should be placed four feet deep in all kinds of soil has been shown to be erroneous in numerous instances where deep drains have not produced satisfactory results, but where shallow ones on the same kind of soil have been followed by salutory effects. The depth found most effective for lateral drains is about thirty inches and not less than twenty-four inches. At this depth a movement of water is established through the soil more quickly than if the drains are deeper, the resistance offered by the soil, being in some instances so great that the water does not reach the deep drain in time to be of service to the top soil.

It may be observed in the second place that for the same reason the drains should be closer together than is required in open soils. Experience has shown that lines of tile placed from thirty to sixty feet apart are efficient, where those at greater distance fail.

SURFACE INLETS.

An aid to underdrains is the surface inlet, which should be placed in depressions where surface water gathers during precipitous rains. While, theoretically, rain should sink into the soil whenever it falls and pass directly into the drains, close soils do not permit this free movement, but the water gathers in pools in the depressions where it remains until the crop is destroyed and the soil loses its natural texture. The surface inlet takes the surplus and keeps the surface of the ground open to the air, a most important factor in keeping such soils in a productive condition.

The inlets may be pits open from the drain to the surface, filled with stone, coarse gravel or brickbats, to prevent rubbish and earth from entering the drain and at the same time permit the free entrance of water.

Before leaving this phase of the subject, I wish to refer to the English law of 1829, under which government loans were granted for the construction of farm drains. A general standard depth of four feet for all drains was required by the government. Mr. J. Bailey Denton, an English drainage engineer of large experience, says, in a published address issued in 1884, that after more than thirty years of observation and experience, he is fully convinced that to follow a hard and fast rule regarding the depth and distance apart of drains has proven to be an error, and furthermore, that depth does not compensate for distance apart in placing the drains. In this experience he has found three feet to be more nearly a standard depth than four feet.

I do not wish to be understood as advocating shallow drainage except for such soils as I have described. This State has a large area of farm land of this character which may be profitably underdrained if the work be done in accordance with the practice which is applicable to such lands. So much discredit has been cast upon underdrainage in certain sections of hardpan districts, that I feel constrained to call attention to the principles and general methods that experience have proven applicable to such conditions, even at the risk of being criticised by those whose experience has been confined to deep, open soils. Tiles have been placed so shallow in many instances which have been cited, that the plow has come in contact with them. That kind of drainage is wrong, of course. Subsoiling and deep plowing should always accompany the underdrainage of close soils and is really an essential part of their treatment.

OPEN SOILS.

For the common type of soils with fairly porous subsoils, an economic and effective depth for laterals is 3 to 3½ feet, the mains being deeper so that the laterals may be properly connected and discharged into them. In some kinds of soils it is profitable to place the laterals at a fairly uniform depth of about four feet. The method of deciding in advance upon the depth at which drains will prove most effective is to observe the readiness or quickness with which the water sinks into the ground after a heavy rain. Several pits should be dug at various points in the field and then by inspection, ascertain how freely soil water seeps into them.

Also observe whether or not the subsoil is uniform in character for the depths to which the drain will be placed and whether it contains a layer of hardpan, sand or other material. Clay loam soils of homeogeneous open structure can be drained at any desired depth, nor will they be injured by the very liberal use of tile, but on the contrary, their ability to endure drouth will be increased.

DISTANCE BETWEEN DRAINS.

The effective distance between drains will be governed in general by the same soil characteristics as their depth, that is, the more open the soil the greater may be the distance apart within certain limitations. Eighty, 100 and even 150 feet may be quite generally used, much depending upon the kind of crops to be grown and the newness of the land. Newly reclaimed land requires fewer drains than old land, so that it may be wise in many instances to plan the work with a view of later placing drains midway between those first installed. The size of the mains, or

receiving tile, however, should be planned for the area to be drained and not for the number of tile which discharge into them. A few lines in open soil will often deliver as much or more water in a unit of time than a greater number of drains in the same area of dense soil.

KIND OF TILE

Round clay tile have long been the standard material for underdrains. They are often called porous to distinguish them from vitrified and glazed pipe familiar to us in sewer pipe. They are not porous in the sense of permitting water to pass through the walls. Water enters the drain through the small spaces between the ends of the tile which do not fit closely when they are laid in the ditch. The tile should be true in shape, uniform in size and burned sufficiently hard to ring when held in the hand and struck with an iron rod. Cement tile are used in large numbers, and if well made are equal to clay tile except in soils charged with alkali salts. Like clay tile, they should be hard, porousity being a sign of weakness. The best tile are made with the mixture of the ingredients as wet as it is possible to use. The absorption of cured tile should be small and the ring clear when struck with an iron rod.

SIZE OF LATERAL DRAINS.

In general the size of lateral or field drains on level land should not be less than four inches inside diameter where the soil is of open character. Close soils requiring less depth and more frequent lines, may be drained with three-inch, the limit of the length of lines of either four-inch or three-inch being about thirteen hundred feet.

A great deal of farm drainage is accomplished by the use of single lines laid through wet spots or depressions. Such drains are required to take the concentrated drainage from a greater or less area and should be five-inch, six-inch or even eight-inch, depending upon the area and slope of the land comprising the watershed of the depression. The efficiency of such lines may often be increased by adding surface inlets such as have been previously described. In passing, I may say that this is the most simple method of draining and often the most remunerative to the farmer in proportion to the cost of the work.

OUTLETS.

As good outlets as possible should be secured for all drains whether they are single lines or are combined into systems.

The outlet tile, if discharging into an open watercourse, may be submerged at times, without injury, if the drain is well laid on a true

grade, however small it may be. It is true, the efficiency of the lower part of the drain may be lessened under such conditions but the construction of ordinary field drains should not be abandoned or deferred on that account. The opportunity for a better outlet may be afforded later, and the drains should be planned on that assumption. I am referring to farm drains as distinguished from district and large projects.

CONSTRUCTION OF DRAINS.

The mechanical construction of drains is important and the carefulness with which it is done often marks the difference between success and failure in underdrainage. Tile drains in clay loam or any firm soil may be laid on very light grades, as for example one-fourth inch per rod if the work is accurately performed. While a large amount of tile are laid in ditches which are graded by the flow of the water in the bottom of the trench as it is prepared for the tile, or "by the eye," it is rarely the case that drains laid in that manner will prove as permanently efficient as those laid by an accurate survey. At one time I thought that possibly some of us placed too great emphasis upon this point, but after many years practice and observation, I am fully convinced that both efficiency and economy will be increased by laying the tile by a survey and further that too great care cannot be exercised from beginning to end in planning and executing the work. The failures, uncertainties and extra cost of work which have come under my observation are sufficient to impress me with the fact that farmers will act wisely if they have every drain which they construct surveyed by some one competent to do such work and who is also able to give helpful advice regarding its execution. To secure accurate tile laying, very little if any water is required in the ditch when it is excavated. It is more convenient in many respects to tile land at a season when it is comparatively dry, for wet farming land is usually dry during some part of the year. On the other hand, some land is so hard that it can be excavated profitably only when it is wet. If the tile are laid by a survey, the work can be done with or without water in the trench, and the drain be finished and secured from injury as the work proceeds from the outlet up grade.

METHODS OF DRAINING THE FARM.

One of two methods may be adopted in carrying out the drainage of the entire farm. The first is to do a little year by year, taking one field after another as the expense can be met by the farmer of limited financial resources. The second is to drain the entire farm or tract as

quickly as practicable by borrowing money, if necessary, and employing the necessary equipment and labor. While the first is usually followed by the small farmer, the second has its advantages and is the best method to pursue in the reclamation of large farms, particularly if the major part is unfit for cropping without drainage.

In a brief paper of this character, I can only call attention to a few of the many features of this important farm improvement with the hope of inducing the farmers of the State to look into the merits of underdrainage, and begin the work at once in a small and experimental way. There are many thousands of acres of fertile land within the boundaries of farms now under cultivation, which are not only unproductive and unprofitable to their owners, but are a discredit to the cause of good agriculture in the State. By underdrainage, these lands can be converted into productive and beautiful fields which will be a delight to their owners, and a source of income to the commonwealth.

Draining the swamps makes it possible to harvest the heavy growth of valuable timber.

MISSOURI DRAINAGE BONDS.

By Thomas K. Smith, Secretary of Compton Bond Company, St. Louis, Mo.

Hundreds of thousands of acres of swamp and overflowed land have been reclaimed and protected by drainage districts organized under the Missouri statutes. Most of this work has been done during the last ten years and practically all of the projects have been financed through bond issues aggregating millions of dollars. The details of the laws concerning the organization of districts and the adoption of a plan of drainage have been worked out very carefully by attorneys for the different drainage districts and the Supreme Court of Missouri has been so very emphatic in construing these laws that there can be no doubt as to their constitutionality. The validity of the drainage taxes has also been passed upon favorably by the Supreme Court of Missouri and inasmuch as drainage bonds are issued to antcipate taxes their legal status has been satisfactory from the start.

All of the drainage systems constructed in the State of Missouri have not been entirely successful but so much land has been reclaimed and the results have been so apparent and have been given so much publicity that the demand for drainage bonds has been constantly increasing. At first the investor who thought he might purchase the land for his own account, if sold for taxes, furnished the only market, then the banks began to purchase these securities and finally the State stimulated the market by making them legal security for State deposits and permitting them to be purchased by insurance companies and estates as well as the permanent school fund. After examining a great many Missouri drainage districts and noting the care taken in their organization and in the adoption of a plan of drainage, I am convinced that under ordinary circumstances sufficient attention is given these details. As a rule the engineering features are carefully worked out and when the drainage system is completed the value of land located therein is considerably increased. From personal observation I am satisfied that Missouri drainage bonds offer as high class of security as can be expected when the rate of interest is considered and am not surprised that the market for these securities has been so active. The first bond issues were offered to dealers on a very favorable basis and were purchased on account of the attractive profits. As the market grew more active the bonds were purchased because they could be easily sold and the competition has been very keen.

The county officials, contractors and engineers have of late years felt that their drainage projects could be easily financed and have given practically no attention to the details of the bond issues, or to the administration of the affairs of the district after the bonds were issued. They have been busy planning and projecting other districts and this lack of interest has resulted in a condition that must be changed if the market for Missouri drainage bonds is to remain as active as it is today. It might be well to note, too, that drainage bonds were first offered in a particularly high bond market when the interest rate offered was especially attracive. In recent years and under less favorable conditions drainage bonds have sold at wholesale on practically the same basis but have been retailing on a much lower basis, which means that the dealer has been handling them on a smaller margin.

After hearing various talks by leading engineers and lawyers who have addressed you, you are probably convinced that through the organization of drainage districts in Missouri a great good has been accomplished and that we can expect more from the future. At this point I want to call your attention to the fact that it is useless to organize a drainage district, adopt a plan of drainage, etc., unless the funds to carry out the same can be secured through the medium of a bond issue. You have had no trouble selling your bonds in the past, but a large number of investors who own Missouri drainage bonds are today trembling when they present their bonds and coupons for payment.

The Drainage law provides that after the tax is levied certain extensions shall be made, that the collection of delinquent taxes shall be enforced in a certain manner and that the proceeds of the collection of the different installments of the tax shall be used to pay the interest and principal of the bond issue and for no other purpose. The law contemplates the payment of all fees and the expense of administration out of the proceeds of the bond issue and it was intended that none of the taxes collected should be used for that purpose.

A few years ago several drainage districts were not prompt in the payment of their interest and principal and offered various plausible excuses for the delinquency. In view of the past good record these excuses were accepted and when the interest and principal was paid after a few months delay nothing further was done by the bondholder. As additional interest and principal payments were necessary these delinquencies began to accumulate and an investigation disclosed a very unsatisfactory state of affairs. It developed that in very few cases had the different installment of the tax been extended in a Ditch Assessment Book as is required by law. As a result of this and the failure of the county

clerk to preserve the records carefully, the amount of taxes actually extended and put into collection was in many cases less than the amount of principal and interest due the following year. If the Ditch Assessment Book had been properly prepared this condition could not have existed. Delinquent taxes had not been collected although the law requires that suit be brought to enforce same within six months. In a number of cases the bond issue did not furnish sufficient funds to complete the system of drainage and appropriations had been made from the tax collections to make the final payments to the contractor. Inasmuch as the bonds were issued for the full amount of the tax a deficit was bound to exist, even if the proper tax levies had been extended because the expenses of administration were being paid from taxes collected. In a number of cases the different installments of the bond issue were made to mature on January 1st, while the taxes out of which the same were payable, were not available until after that time.

The result of this failure to work out a system of administration has been that a number of counties in the State have been delinquent in the payment of the interest and principal of their drainage bonds and that a number of districts are in actual default. In a great many cases a proper system of administration has been worked out, bonds have been issued for but 90 per cent of the tax levy, the county clerk has been required to prepare the Ditch Assessment Book and the different accounts have been properly segregated. It is impossible, however, to so arrange the affairs of every drainage district in the State because the present law does not cover the question of administration as it should. If all drainage issues were purchased by dealers who are competent to outline a proper system and the different officials were willing to do so no further legislation would be necessary, but in order to avoid further delinquencies and to straighten out the districts now in trouble, certain legislation is absolutely necessary. Provision must be made to enable the old districts to pay their interest and principal promptly so that the standing of drainage bonds may be restored. If this is not done, future issues will not meet with ready sale and the State would not be justified in accepting them as security for State deposits, or permitting their purchase by insurance companies, estates and by the permanent school fund.

In order to place the Missouri drainage bonds heretofore issued on a proper basis and prevent delinquencies and defaults in the future, I suggest the following changes and additions to the present law:

1. Provision should be made that bonds may be issued in an amount not to exceed 90 per cent of the tax levy and that the levy may be increased at any time, if necessary, to pay the interest and principal of the

bonds. If at any time the tax levy is found to be illegal or irregular, provision should be made for the levying of another tax. The total number of installments of the tax should be extended in a Ditch Assessment Book so that it will only be necessary for the county clerk to copy the installment for a particular year. The different provisions should be made mandatory and the bondholder given the right to enforce same by mandamus.

2. The law should provide that suits for delinquent taxes shall be brought as soon as the delinquent tax books are returned. This should be made the imperative and mandatory duty of the collector and the bondholder should be given the right to enforce same by mandamus.

3. No drainage bond should mature earlier than April 1st or later than July 1st in the year following that of the maturity of the installment of the tax out of which they are payable.

4. All tax collections should be preserved in a separate account to be used for the purpose of paying the interest and principal of the bond issue and for no other purpose.

5. The fees of the different officials should be mentioned in the law so that there can be no controversy—in some counties the collector receives but one per cent, which is not sufficient to justify the efforts required to collect drainage taxes—in other counties he receives four per cent which is too much.

6. Frequently the first semi-annual payment of interest matures before the tax can be collected. The district should be permitted to pay this out of the proceeds of the bond issue.

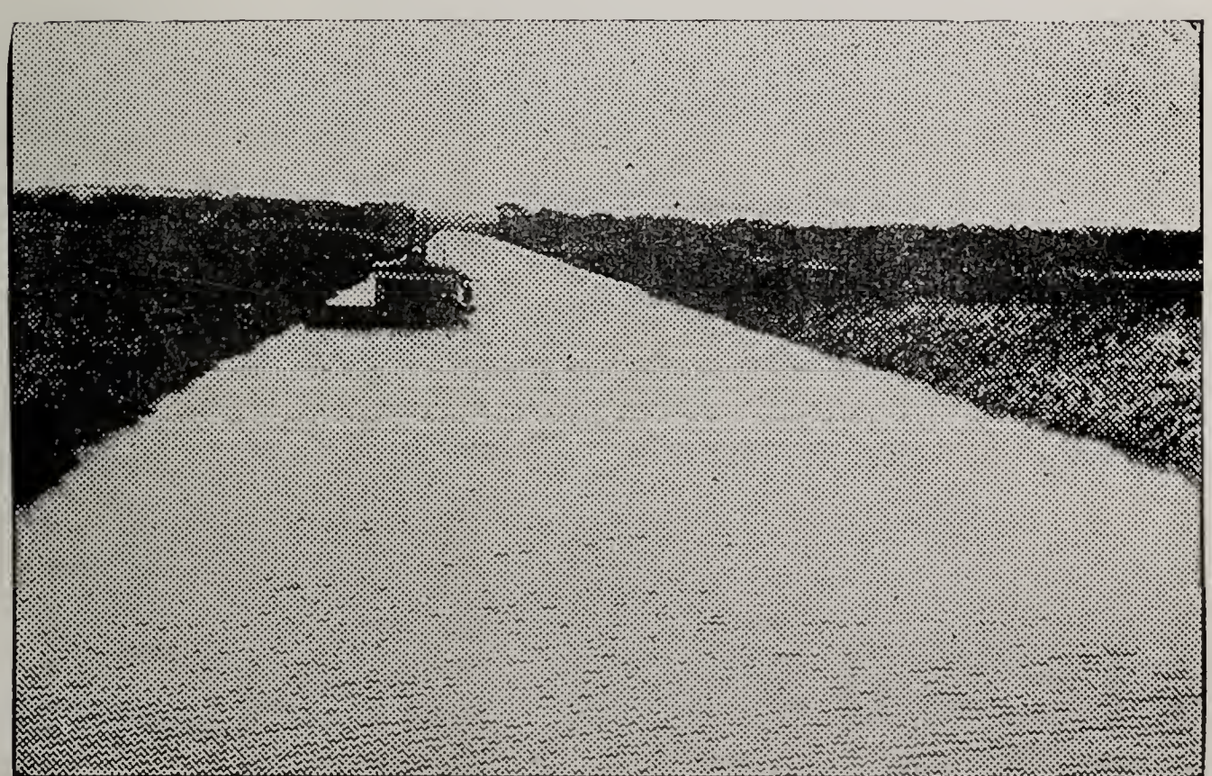
7. Under the county court law the county treasurer should be required to preserve all drainage funds in a bank account, separate and distinct from other county money. He should also be required to give bond for the proper preservation of the same. This provision is necessary because of the weak system of administration existing in most counties of the State where it is impossible to check up the financies, and until this is done it is impossible to determine whether the drainage funds are intact.

8. County courts should be permitted to refund outstanding drainage bonds that mature before the tax collections are available and to extend the maturities, say not more than six months. This will make it possible to correct the delinquencies existing at present in a number of counties.

If the above suggestions are embodied in carefully prepared provisions of the drainage law, I am confident that the market for Missouri drainage bonds will be restored and improved, and that future issues will

command a ready sale, thereby providing sufficient funds to make possible the reclamation of the enormous area of swamp and overflowed land in this State.

I submit that a proper system of administration may be worked out under the present statute, but we have learned from experience that in order to be certain that the proper steps are taken they must be clearly outlined in the law and the bondholder must be given the right to enforce same by mandamus.



BIG TARKIO DRAINAGE DISTRICT IN HOLT COUNTY, MISSOURI.

THE NATIONAL DRAINAGE CONGRESS.

While the ninteenth annual meeting of the National Irrigation Congress was being held in Chicago from December 6 to 9, 1911, the sentiment in favor of land drainage was so strong among delegates from the various states it was evident the time was ripe for the creation of a separate body which would have for its purpose the encouragement of land reclamation by the construction of drains and levees. Hon. B. A. Fowler, President of the National Irrigation Congress, in his annual address recommended that the delegates interested in land drainage form such an organization to work in harmony with the National Irrigation Congress.

Acting upon this suggestion, Mr. Edmund T. Perkins of Chicago, President of the American Reclamation Federation, issued the following call:

"Time and again has the National Irrigation Congress, by resolution called the attention of the Federal Government to the imperitive need of action in the matter of reclamation of swamp and overflow lands, a matter which vitally concerns the health and wealth of the nation, but the chief interest of the National Irrigation Congress is the reclamation of waste lands by irrigation, and it is deemed necessary to organize a separate association to promote the reclamation of lands by drainage.

"Therefore. By the authority vested in me by the American Reclamation Federation, I hereby invite all those interested in the reclamation of swamp and overflow lands to be present at the Hotel La Salle, Thursday vening, December 7th, at 8 o'clock, in the College Room, that such association for this purpose may thereby be organized."

The meeting was held pusuant to that call and Mr. Edmund T. Perkins called the meeting to order and was elected Chairman. Mr. John H. Nolan, Special Agent of Missouri in land reclamation, was made Secretary. Colonel E. J. Watson, Commissioner of Commerce and Industries of South Carolina; Mr. Samuel H. Lea, State Engineer of South Dakota; Hon Geo. H. Maxwell, Pittsburg, Pennsyvania; Hon. James R. Garfield, of Ohio, Secretary of the Interior under President Roosevelt; Hon. Gifford Pinchot of New York, Chief Forester of the United States under President Roosevelt; Mr. M. O. Leighton, Chief Hydrographer of the United States Geological Survey, Washington, D. C.; Hon. B. A. Fowler, President of the Irrigation Congress, and many other prominent men discussed the advisability of undertaking to

organize a drainage congress at that time. The sentiment in favor of such a movement was almost unanimous among 350 persons present.

The Chair was empowered to appoint a committee on temporary organization to take into consideration what course should be pursued in the matter of perfecting a permanent organization. The committee at

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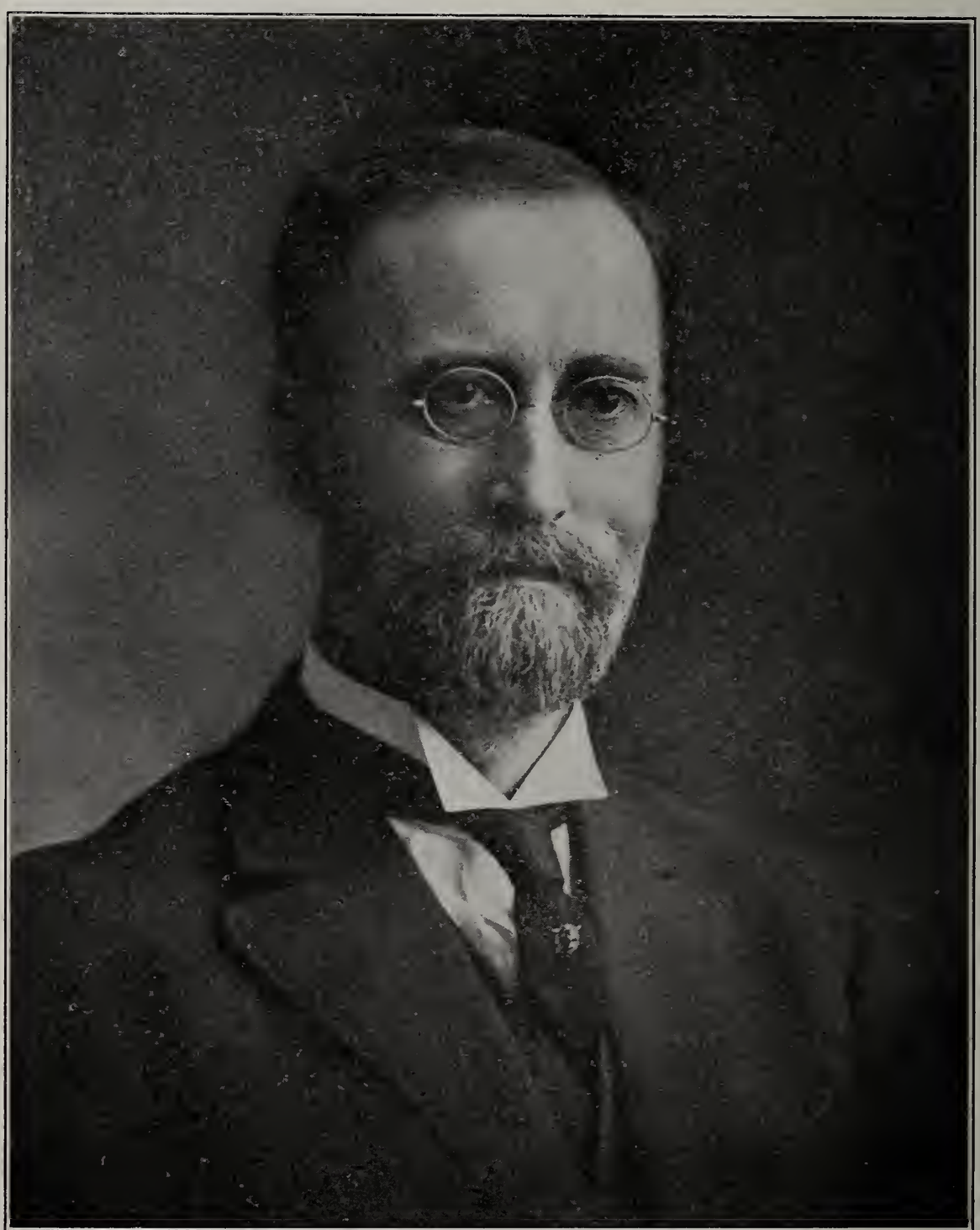
Hon. David R. Francis of St. Louis, Mo., president of the National Drainage Congress.

the next session, held December seventh, made the following recommendation:

"We, your Committee on Temporary Organization, appointed by the Chair at the first meeting after due deliberation have unanimously agreed to recommend to this body that a permanent organization be created, and be designated The National Drainage Congress."

The report was unanimously adopted. The Committee also offered a constitution for the new organization and both the report and the constitution were adopted.

At the meeting held Friday evening December eighth, the invitation from the Progressive Union of the City of New Orleans, asking that



Jacob A. Harman, C. E., Peoria, Ill., honorary vice-president of National Drainage Congress, and chief engineer for Elsberry Drainage District, Lincoln county, Missouri, and Fabius Drainage District, Marion county, Missouri.

the second annual meeting of the National Drainage Congress be held in that city, was read and accepted.

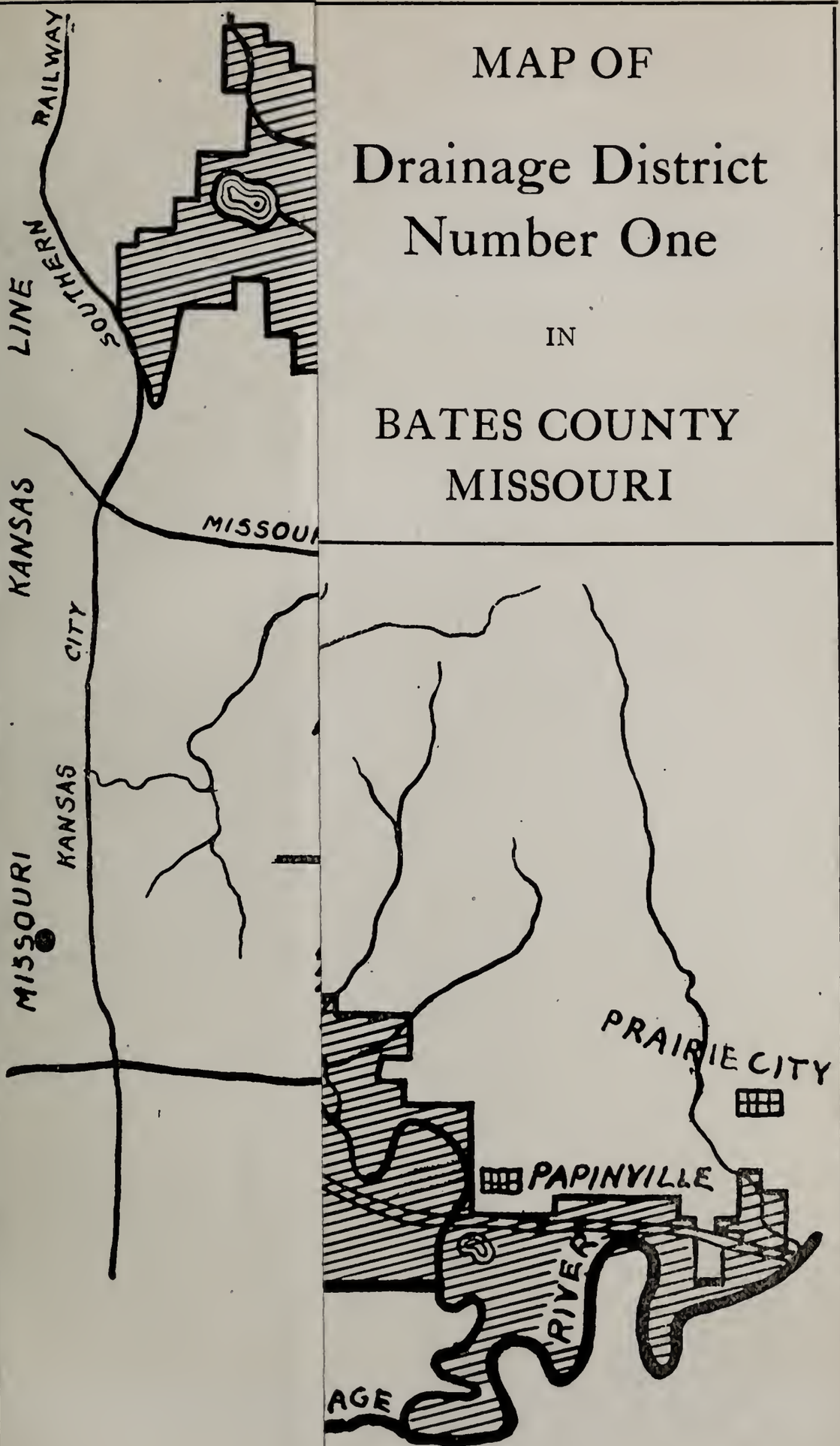
Mr. Edmund T. Perkins of Chicago was elected First Vice-President of the Congress; Colonel E. J. Watson of South Carolina, Second

MAP OF

Drainage District Number One

IN

BATES COUNTY MISSOURI



DRAINAGE District No[illegible],350 acres and when completed 5,100,000 cubic yards of earth [illegible]arias des Cygnes river, averaging 12 feet deep, 64 feet wide at the to[illegible]s made 60 feet wide at the bottom, from 85 to 110 feet wide at the t[illegible]completed about five years ago and the top of the new channel has bee[illegible]e of ten feet deeper and reducing the length of the old channel by cutti[illegible]carry away the floods. The plans for this district are similar to the r[illegible]ges 37 to 40 of this report.

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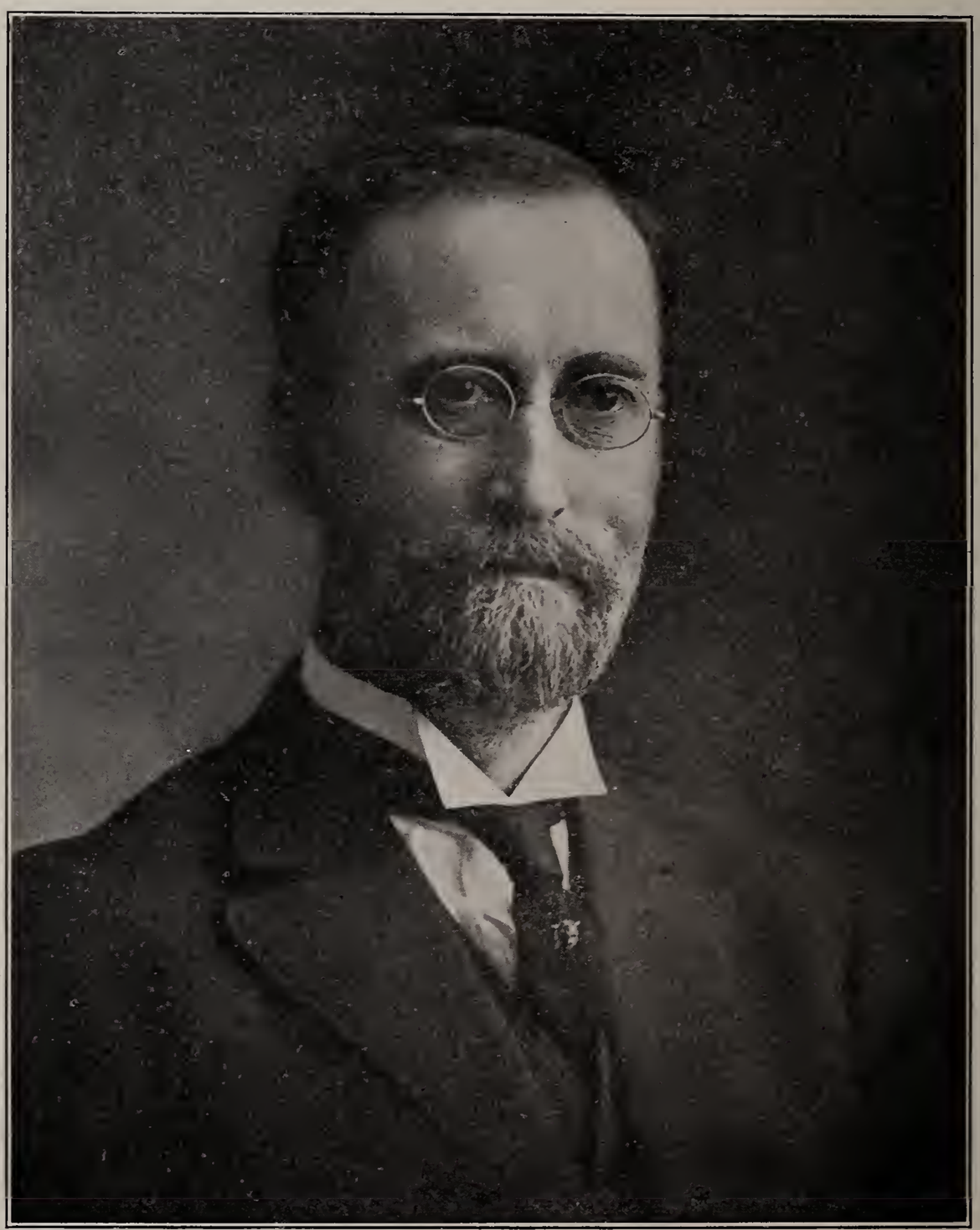

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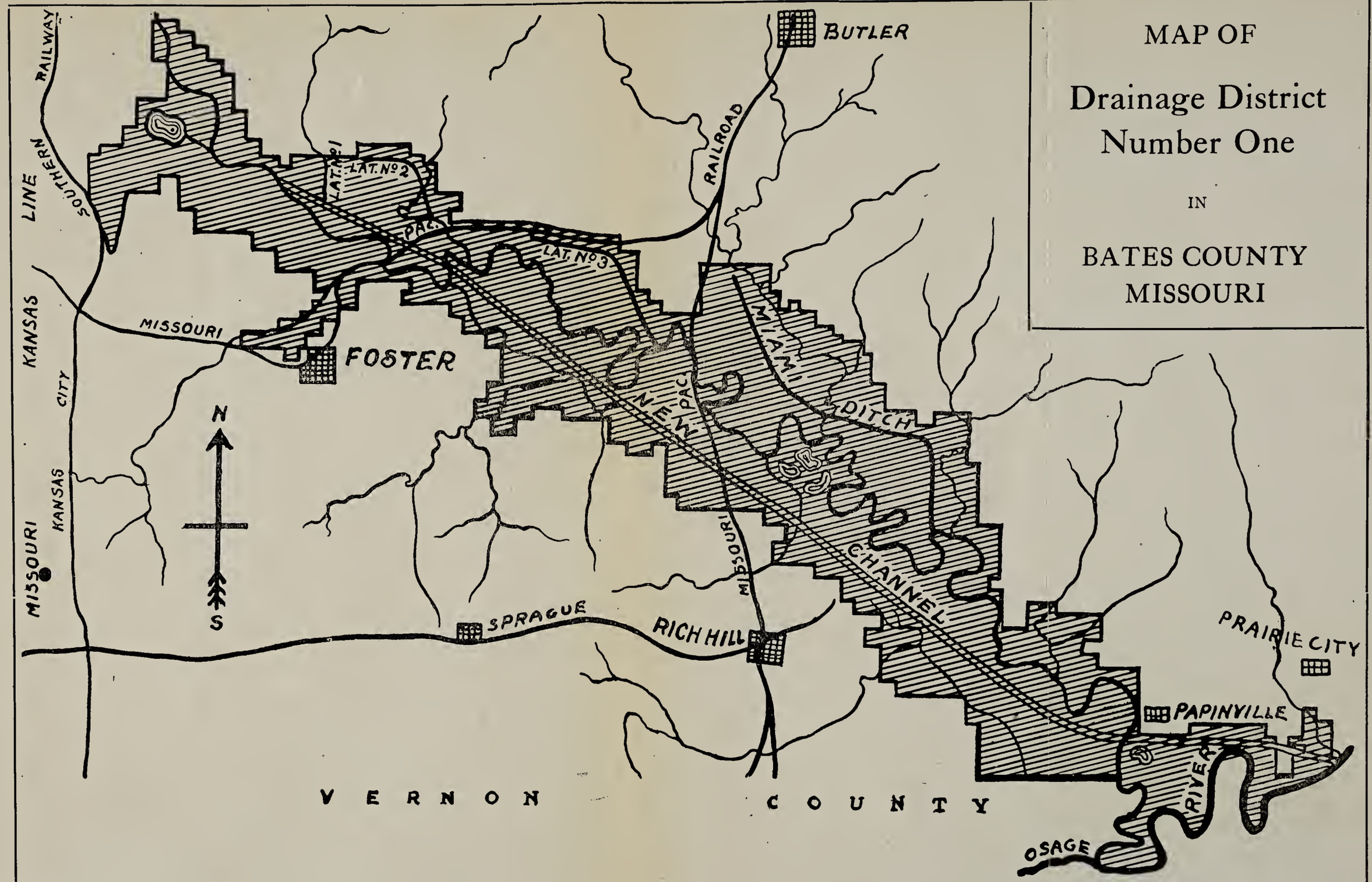
the second annual meeting of the National Drainage Congress be held in that city, was read and accepted.

Mr. Edmund T. Perkins of Chicago was elected First Vice-President of the Congress; Colonel E. J. Watson of South Carolina, Second



DRAINAGE District No. 1 of Bates county is the second largest district in Missouri outside of the southeast part of the State. It contains 41,350 acres and when completed 5,100,000 cubic yards of earth will have been removed. Twelve miles of lateral ditches were constructed some years ago, and a new channel for the Marias des Cygnes river, averaging 12 feet deep, 64 feet wide at the top and 40 feet wide at the bottom, was constructed for 19 miles. The last four and one-half miles of this new channel was made 60 feet wide at the bottom, from 85 to 110 feet wide at the top and 15 feet deep. The old channel which winds around through the same bottom is 73 miles long. This work was completed about five years ago and the top of the new channel has been widened from 20 to 30 feet by the erosion of the waters. The district now is engaged in digging the channel an average of ten feet deeper and reducing the length of the old channel by cutting off a number of large bends. When this work has been completed the valley will have two channels co-operating to carry away the floods. The plans for this district are similar to the method adopted for the Valley Drainage District in Shelby county, Missouri, and which has been described at length on pages 37 to 40 of this report.

Vice-President; Colonel Wm. C. Gorgas, in charge of the sanitary department of the Panama Canal, Third Vice-President.

The constitution as adopted contains the following important provisions:

The Congress shall be known as the National Drainage Congress.

The objects of the Congress shall be (1) to promote and to diffuse knowledge concerning the reclamation of lands in all those states of the Union where drainage reclamation would be beneficial, and also concerning the artificial application of water to lands requiring irrigation in such regions; (2) to promote navigation by means of canals built for drainage and by improvement of the natural streams into which such canals are discharged; (3) to conserve and impound water for drainage, humid-land irrigation, or flood protection purposes; (4) to conserve and control natural resources pertaining to agriculture; (5) to restore and preserve soils by rotation, fertilization, and overflow of silt; (6) to remove the menace to the public health of the Nation which the presence of undrained lowlands constitutes; (7) to facilitate conference and deliberation among the people of the country concerning drainage and related interests, especially to promote agreement and concerted action among those organizations interested in the conservation and proper utilization of our natural resources to the end that united efforts may be toward agreed-upon ultimate results; and (8) to provide means for bringing the needs of the people and the country before State and Federal governments.

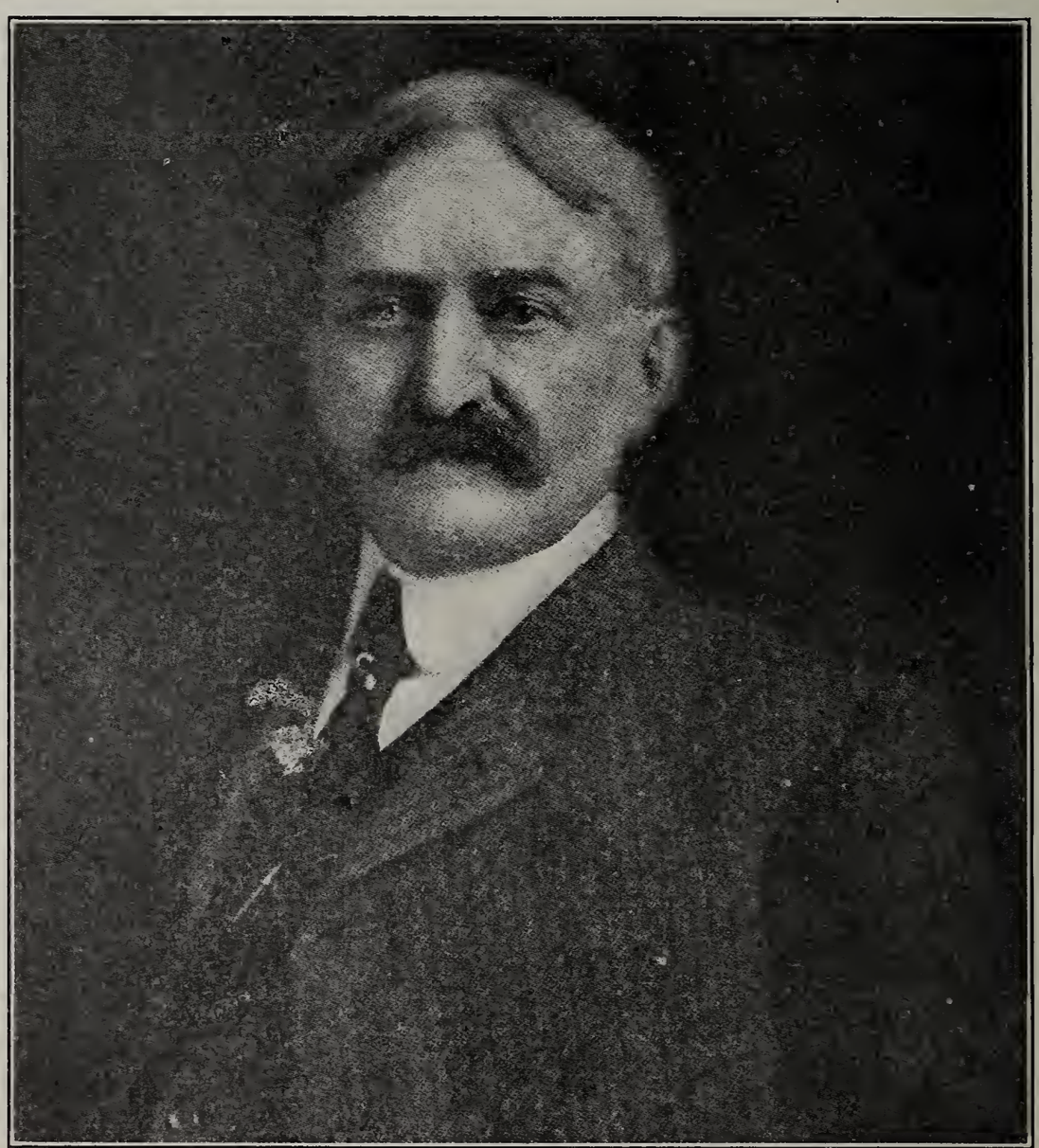
Its scope shall embrace a broad, unbiased, and comprehensive consideration of the objects as herein set forth, from a national viewpoint, for the good of the entire commonwealth and that of agriculture in particular. It shall have no political affiliations nor permit political matters to enter into its business or discussions other than those which pertain to the objects of the Congress.

Regular annual sessions shall be held at such places as the Congress shall determine and at times set by the Board of Control and approved by the Executive Committee.

Special meetings of the Congress or of its officers, boards, and committees, may be held at times and places determined by the Congress or the Executive Committee.

The membership of the Congress shall consist of (1) fifteen delegates from each state, to be appointed by the Governor thereof; (2) ten delegates from each city having a population of over twenty-five thousand and over one thousand, to be appointed by the mayor or chief executive; (4) five delegates from each county, to be appointed by the

Chairman of the governing board; (5) two delegates from each incorporated town having a population of less than one thousand; from each regularly organized association devoted to drainage, irrigation, or other reclamation work, agriculture, horticulture, and engineering; and from each college and commercial body concerned with public interests which has been duly organized not less than one year; (6) all duly accredited members of state and federal drainage, irrigation, water, or conservation commissions; (7) all state engineers and state commissioners of



D. E. King, St. Louis, Mo., honorary vice-president of the National Drainage Congress.

agriculture and horticulture; (8) all officers, chairman of committees, members of the Executive Committee, Honorary Vice-Presidents, members of the Board of Control, and permanent delegates of the Congress; (9) the governor of each state, and the mayor of each city and town having a population of over one thousand; (10) the President of the United States and all members of his cabinet, and (11) all members of the United States Senate and House of Representatives.

The following resolutions were adopted:

"Whereas, There are in the United States more than 75,000,000 acres of swamp and overflow lands that are non-productive and a menace to public health, and

"Whereas, The drainage of this land will be promotive of the public health and reclaimed for agricultural pursuits, and materially aid navigation, and add several billions of dollars to the wealth of the Nation, and

"Whereas, The reclamation of these lands is a public function, affecting the health, welfare and material development of the Nation;

"Therefore, Be it resolved by the First National Drainage Congress that the Congress of the United States is earnestly requested and urged to enact such laws as may be necessary to reclaim and make useful such swamp and overflowed lands, to insure their highest development under such provisions as may be deemed best, and we do especially recommend the creation of a National Commission to make the necessary surveys and estimates of cost and to work out a comprehensive plan of National Reclamation in connection with the several States, designed to co-ordinate the mutual interests of the various States in a practical State and Federal System of consistent and progressive drainage, reclamation and development; and that sufficient funds be appropriated by the National Government to carry on the work of the Commission.

"That the National Drainage Congress calls upon the legislatures of all those states within the overflowed area to immediately and forthwith enact and put upon their statute books state drainage laws in case there are not now such laws, and that the laws when enacted be as nearly uniform with the laws of other States as possible."

The second meeting of the Congress was held at New Orleans, Louisiana, April 13 to 18, 1912. The program consisted of addresses delivered by such eminent authorities on land drainage as Mr. Edmund T. Perkins, First Vice-President of the Congress; Hon. David R. Francis, of Missouri; Mr. Jacob A. Harman, Civil Engineer, Peoria Illinois; Senator Francis G. Newlands of Nevada; Senator-elect Joseph Ransdall of Louisiana; and many other men of prominence interested in the reclamation of swamp lands of this country.

The Convention was attended by 667 accredited delegates representing 34 different states. This attendance was considered remarkable, for the Congress was in session at the time of the high water which prevailed in the South in April, and which prevented many persons from attending who otherwise would have been there.

The officers elected for the ensuing year are as follows: President, Hon. David R. Francis, former Governor of Missouri; First Vice-Presi-

dent, Edmund T. Perkins, President of the Perkins Engineering Company, Chicago, Illinois; Treasurer A. M. McLachlen, President of the McLachlen Banking Corporation, Washington, D. C.; Honorary Vice-President from Missouri, D. E. King, Industrial Commissioner, Missouri Pacific Railway; Member of the Executive Committee from Missouri, John H. Nolen, Special Agent of the State in land reclamation.

The next meeting of the Congress will be held in St. Louis, Missouri, February 26 to 28, 1913. St. Louis was selected because the control of the Mississippi river and the protection of the valleys along its course are recognized as the most important problems in land reclamation confronting the American people.

The lead that Missouri has taken in the land redemption movement was also an important factor in securing the 1913 meeting of the Congress for the Missouri metropolis.

The Officers of the Congress predict many thousand delegates will attend the next meeting. The ablest speakers and best informed men on matters of drainage will be present and deliver addresses.

Corn is King on drained land.

"THE MISSISSIPPI VALLEY"

(Address delivered by Hon. David R. Francis, Former Governor of Missouri, before the National Drainage Congress at New Orleans, Louisiana, April 10, 1912).

There have been problems requiring solution by the electorate of this republic ever since the government was organized, but seldom, if ever, in our history have we ever been confronted by difficult issues as numerous and varied as those of today. The questions are social and economic, governmental and political, financial and commercial, practical and theoretic; they require and receive the diligent and persevering effort of the best minds of the age.

I do not refer to the issues between the two great political parties of the country for the membership of these parties is each divided into two factions on those very questions. Such factions are called radical and reactionary or progressive and conservative. The underlying principles and fundamental doctrines of both parties are involved in such issues. The lines of demarkation are not clearly defined in the minds of many, but are daily becoming more nearly so. This struggle is not a war against property as many patriotic people believed it to be a decade ago, and as many selfish property holders will contend; nor would I call it an advocacy of socialism, although the trend is in that direction; nor is it an organized effort to change the nature of our institutions. Rather is it a protest against existing conditions based on the theory that the great inequalities prevailing in wealth and influence are the result of laws or of carelessness or want of rectitude on the part of those by whom the laws are administered, enacted and construed. Equality of opportunity under the law is a basic principle of our government, and nothing so incenses the people as a step or an inclination to subvert it. Furthermore, with the growth of wealth and the increase of population and the expanding of culture in a community or a state or a nation, there goes a feeling that the unfortunate or the incompetent are the wards of the state and should be cared for at the expense of those who are able and whose accumulations the state protects.

Whether we are conservatives or progressives all should feel that humanity is our first consideration, and only he who is willing to sacrifice personal interests for the perpetuity of our institutions, is worthy of American citizenship. Out of this controversy and apparent conflict of interests good is sure to be evolved. The sober second thought will find a solution for these problems. The patriotism of America

will again survive a great crisis, will demonstrate to the world that her people can govern themselves with justice and wisdom and perform their part toward the uplift of humanity and the betterment of society. The radical of the last century may become reactionary of this; we may be drifting inevitably toward socialism, but if so the goal will be enlightened socialism, and will be attained only because no other end will insure the brotherhood of man and the welfare of the race. In my judgment, however, such will not be our fate.

You may say I am digressing from the object of this meeting. I admit it so appears. Such thoughts, however, naturally arise in any reflective mind when considering a work as stupendous, as far reaching and as lasting as that which calls us together. The magnitude of undertaking, however, should not appall us when we know that it means reclaiming an empire; when we realize that if successfully projected it will result in providing happy homes, lucrative employment and independent living for tens of thousands of families who otherwise might be doomed to eke out livelihoods of dependence and want, and possibly become wards of the state and enemies of society.

Such plans as we have met here to promote are not only sanctioned and justified for an economic viewpoint but are a duty to the sections to be benefited and to the entire country and also to the generations that come after us. If Jefferson and Monroe and Livingston could have looked ahead when they acquired the Louisiana Territory and have had the prescience to see what a boon they were conferring not only on their country but on the human race, the author of our Declaration of Independence would have had no doubts or misgivings as to his authority to make the purchase, and Monroe and Livingston, its negotiators, would have realized that they were making for themselves a monument as enduring as the republic itself. If our forebears who were potential in extending our western borders to the Pacific could now see the thriving cities and fruitful fields that bedeck what were thought barren wastes of dense forests fit only for the abode of wild beasts, they would feel amply compensated for all their effort and sacrifice. So will generations to come look back with gratitude and admiration to us if we make to blossom and bear the places now waste and barren.

I have no personal interest whatever in any swamp or overflowed lands and will not be directly benefited by their reclamation, but every man who cherishes a desire for the growth and prosperity of the country should do his part in promoting and aiding this great work. I have just returned from a visit to the Pacific Coast and to say that the people that inhabit that fertile, prolific and salubrious section are

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NEW MADRID COUNTY

COUNTY

DUNKLIN

ARKANSAS

MISSISSIPPI RIVER

Point Pleasant

Portageville

Portage Bay

Twp. 21 N.

Twp. 20 N.

Twp. 19 N.

Twp. 18 N.

Twp. 17 N.

Twp. 16 N.

Floodway of Little River Drainage District

System of Drainage Ditches

Levee

Prisco Railroad

Pascola

Southwestern Drainage System

Prisco Ditches

Railroad

Hayti

Cayaso

Range 12 E.

Range 11 E.

Range 10 E.

Range 9 E.

Deering

Deering

D. and S. R.R.

Caruthersville

System of Drainage Ditches

Pemiscot Bay

Levee

System of Drainage Ditches

MAP
OF
PEMISCOT COUNTY

Symbols.

- County Lines.
- Township
- Existing Ditches
- " Levee
- Railroads
- Proposed Ditches.

Prepared by
John H. Nolen, Special Agt.
December, 1912.

sanguine as to its future, does not partially express the supreme confidence they feel as to their growth in population, wealth and influence. The emigration from the Mississippi Valley to the Pacific coast is enormous and is increasing from week to week. My state, Missouri, and your and every state east of the Rockies is sending her sons and daughters to develop the resources of Canada or the Pacific coast states, when at our very doors opportunities can be offered which can not be surpassed if equaled anywhere on the globe. In Florida, eighteen million acres of rich soil, all within the borders of one state, are being drained and ditched and will ere long be under cultivation. It behooves us of this valley and of all sections where there are overflowed lands to look to our laurels, if we would maintain the position we occupy in the sisterhood of states.

The early completion of the Panama Canal and its opening to the craft of every clime, will have an effect on the commerce of this valley, of the entire country and of the world, which it is impossible at this time to calculate or define. Our products, whether of the soil, mine or factory will in the Orient and in South America come into active competition with those of Europe. This queenly crescent in which we are met to give impetus to a movement of national importance will surely be a great beneficiary from the union of the Atlantic and Pacific. I should like to see the assembling here of the war fleets of all nations preparatory to their traversing the Canal as is planned, and steaming through the Golden gate to San Francisco Bay to join in celebrating the greatest achievement of modern science, a magnificent product of human energy—the Panama Canal.

Think of it! Seventy-four million acres of rich alluvial soil, between the Rockies and the Atlantic withdrawn from cultivation and occupancy because of failure to adopt a systematic drainage scheme, which science and experience have demonstrated would be feasible and neither difficult nor costly. An empire about equal in area to that of the superbly productive states of Ohio, Indiana and Illinois. Capable of furnishing homes of forty acres each to one million eight hundred and seventy thousand American families. All of it fertile soil and susceptible of producing enough to subsist a population of tens of millions of human beings. A kingdom over twenty times that of Alsace and Loraine, the territorial prize of the sanguinary Franco-Prussian war, to the relinquishment of which the French people have never become reconciled, as attested by the fresh flowers in which the two statues representing those two provinces in the *Place de la Corde* at Paris have been wreathed and constantly renewed for forty years.

It is a crime to longer neglect the reclamation of these lands. Do you ask why government aid should be necessary for the successful prosecution of the work? I answer there is a multitude and variety of reasons. Because the Federal Government is the only power or authority that can unify the many and often conflicting interests involved. Missouri has enacted a statute under which some of our overflowed lands have been drained, but our Arkansas neighbors fear the water when it has found its way to their swamps. Furthermore, a plan sufficiently comprehensive to be effective must cross not only private ownership and country boundaries but state lines as well. If the General Government can irrigate arid lands, why can it not drain overflowed lands on the same general plan which makes the cost incurred a first lien on the land reclaimed and confers a great benefit on the people and the country without ultimate expense to the government?

The welfare of the people is the first consideration of the government and that welfare can not be promoted or conserved without due regard to sanitary conditions. Swamp lands are a constant menace to public health; they breed insects which produce malaria and propagate a horde of pestilential horrors.

The Federal Government has surveyed these lands, has the topography and all the records pertaining thereto, and has in its employ skilled and experienced men well qualified to design a practicable drainage plan, uniform in its general application and well adapted to meet varying characteristic conditions.

Private capital and American enterprise will surely and promptly utilize all reclaimed lands to the benefit of all classes and all sections. The rapid increase in our population demands enlargement of our productive capacity if we would avoid being a food importing country. Twelve or fifteen years ago my St. Louis house had a branch in this city, and we were annually sending to Europe through this and other gulf ports millions of bushels of wheat and corn. That branch was discontinued for want of business; nor has the present house exported a bushel of grain in ten years.

It is only new land in this country now that is devoted to the growing of surplus grain and the new land that is tillable is about all taken. Our surplus is growing "smaller by degrees and beautifully less" from year to year and will ere long reach the vanishing point. No time is to be lost in utilizing the productive energy of all our cultivable lands.

The states in which are these overflowed lands of swamp acres, and they are all the states of the Union, excepting six or seven, gave their moral support and legislative aid to the irrigation schemes that resulted

in the Reclamation Act of 1902. This would be no new departure in governmental policy, but the continuance and broadening of a wise plan that will increase the wealth of the country and enhance the happiness of all the people.

And what disposition will the government make of its enormous and unequaled collection of machinery now being used on the Panama Canal? Will it put it in the scrap heap or sell it for a song to some shrewd purchaser who knows how to utilize such implements? They were paid for, or will be when the bonds mature, by all the people including the owners of our swamp lands. To what more practical use and more far reaching benefits could such machinery be devoted than in the reclamation of our swamp lands? It would yield a return hardly second, if not equal, to that which we hope will follow its present application.

This Congress is the outcome of an agitation by discerning, thoughtful men, who have given the subject careful and patriotic consideration. Their conclusions as to the importance of the work are incontrovertible and such men are entitled to credit and gratitude for inaugurating a movement fraught with such far reaching results and pregnant with possibilites of such consequences and weight.

May the interest here manifested deepen and widen until every state and every community is aroused to a sense of duty to push to a speedy consummation a work which is national in its scope and humanitarian in its effect.

ADAPTABILITY OF DRAG LINE EXCAVATORS FOR DRAINAGE WORK.

By Frank B. Knight, Sales Manager Lidgerwood Manufacturing Company, Illinois Member of The Executive Committe of National Drainage Congress, Chicago, Illinois.

There is no type of machine probably which has swung into prominence as quickly and forcibly in connection with drainage excavation as has the drag line excavator. Since the advent of this machine it has made possible the digging of ditches and constructing of levees larger than it had been possible to build them in the past. I will endeavor to explain below why this is made possible with the use of the drag line excavator. The machine itself resembles a revolving derrick; the engine platform, engine house and boom being connected and revolving on a turntable which is supported on a lower frame or car, this car being mounted on trucks, wheels or rollers, as the occasion requires. The material used in the construction of the main structure of these machines may be either steel or timber. The machinery is especially designed and built for strength and durability as well as speed and power, which are most particularly important for machinery used in excavating operations.

The bucket used in connection with the drag line excavator is of the scraper type. It is connected to the main engine by means of two wire ropes, namely: the hoisting rope and the drag line rope. The bucket is filled by the bucket engine dragging it toward the machine and when filled is hoisted by the same engine through the hoisting rope passing over a sheave at the outer end of the boom, and the boom and entire upper frame are then swung over the point where it is required to dump the bucket. There are several devices for dumping the bucket, all of which are built with a view of assuring a quick and positive unloading, as this is very necessary when digging sticky or hard material.

There is required as a crew for operating the machine only two men, the operator and fireman, on the steam machine, and in the case of gasoline and electrically driven device, an operator and oiler. In addition to these two men there are only required two men on the ground to tak care of track or cribbing on which the machine runs. This feature is a saving for the contractor over the cost of operation of any other type of drainage excavator, as there is required on other types from three to five men for a crew. It might be said also that this feature of only requiring two men is due to the efforts of the lead-

ing manufacturer of this type of machine in equipping them with automatic controls of the machinery embodied on them, which practically eliminates manual labor in the operation, and at the same time assures a capacity which is not dependable upon human endurance, which is the case in other types of excavators.

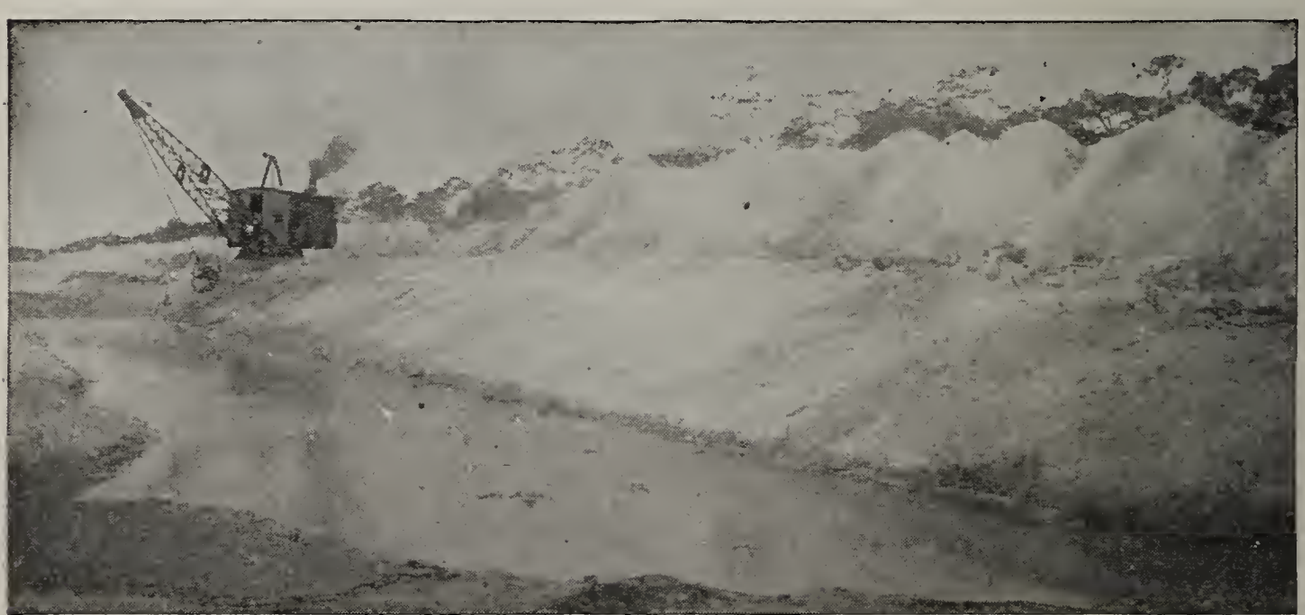
The success of the drag line excavators on drainage work has become eminent through their performance in this and other countries. The machine is designed so that it can accomplish the excavation of the drainage ditch and the construction of the levees by working while sitting on the ground level and not in the ditch as is the case with other types of excavators. They are capable of digging and depositing anywhere within a complete circle, the boom and engine frame platform being designed so that it assures a full circle swing. The radius of action of one of these machines, owing to the above feature, is a little over twice the length of the boom, by this I mean that the machine is capable of

This view shows one position of the drag line while in operation.

digging at a point and depositing the material at a distance of twice the length of the boom from the point at which the material was dug. The writer had brought to his attention a striking example of this tremendous radius of action while in Florida recently, this example was in the form of a drainage canal dug by two drag line excavators equipped with seventy foot booms, one machine working from each side of the canal, the excavators sat on the berm accomplishing the excavation and depositing the material in levees at a point diametrically opposite the point from which it dug; when completed the distance between the foot of the levees was two hundred and forty feet, the top width of the canal was one hundred and forty feet, and the levees had a base of forty

feet each. I am positive that no other type of machine could have dug this canal and constructed these levees in one operation as these machines did.

The lower frame or car upon which the drag line excavator is mounted is designed with a view of having a broad base which gives the excavator a bearing surface which will allow it to work on ground that is too soft for men to walk upon. Another striking capability of the machines is their ability to work through swamps, slightly inundated by water. This has been accomplished by several drainage contractors who have found that the surface water lying on the same level at which the machine works, namely: the ground level, will drain into the ditch which the machine excavates, leaving the ground in a state of comparative dryness around the excavation work, which will allow the machine which the operator requires.



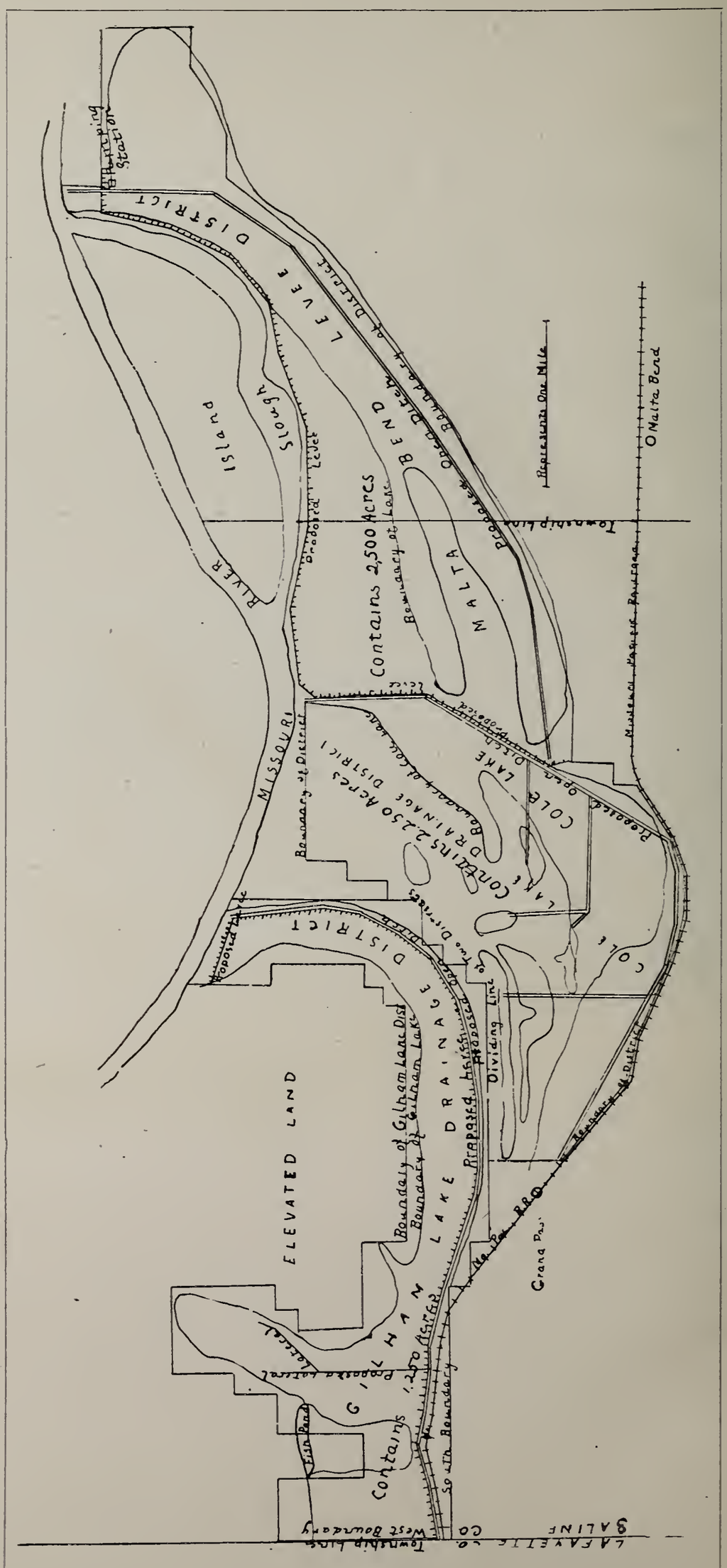
Another view of the drag line machine.

Owing to the small crew required on these machines and their high capacity, they have made possible also the digging of drainage ditches of a type which cannot be built by other machines, at a cost per cubic to move successfully and easily.

Another advantage attached to the drag line excavator is its ability to trim long slopes of drainage canals simply by the manipulation of the bucket by the operator. The slope of a drainage ditch dug by a drag line excavator are not dependent on the length or sweep of the bucket as is the case when a bucket is fastened to a dipper stick. The drag line bucket can be hoisted and dragged through the ground at any angle yard which is reasonable and low enough to allow the extensive reclamation of isolated swamp lands which is now being accomplished. From statements which the writer has received from projects where this type of machine is being used, he has learned that this digging is being accom-

plished at from 5 to 7 cents per cubic yard, depending on local conditions and the kind of material to be dug, and the efficiency of the organization employed. The above figures included labor, fuel, repairs and also camp and board expenses. A fair average yardage of these machines, in 10 hour shifts, ranging from 1000 to 1500 cubic yards, this being governed by the size of the machine. The fact that the manufacturers are building these machines equipped with not only steam power, but electrical and gasoline power, has made them adaptable for accomplishing drainage work under all kinds of conditions, the contractor not being subject to the scarcity of any one class of fuel or good water.

The writer does not wish to give the impression that there are no drainage projects upon which a drag line excavator cannot be used as there are some, especially cases where the ground is completely inundated with several feet of water, which class of work of course, can be accomplished practically with only one type of machine, namely: the floating dredge, however, where conditions are similar to ones which I have outlined previously, I have not in my experience seen any type of machine with the flexibility, radius of action, together with capacity, that the drag line excavator possesses, and in view of this consider it a valuable tool for every drainage contractor.



Map showing outline of three reclamation districts In Saline County Missouri.

THE DIPPER DREDGE FOR DRAINAGE WORK.

By Arthur F, King, representing the Marion Steam Shovel Company, Marion, Ohio.

Three-quarters of a century ago America was, in a large measure, a new and undeveloped country. The population at that time was comparatively small; industry was in its infancy; there were very few large cities and towns, and land was very plentiful. Most of the agricultural activity was centered along the Atlantic seaboard and in those states immediately west of the Allegheny Mountains. There was little thought of occupying the great expanse of land west of the Mississippi. The people of that day produced, very largely, everything they consumed. There was no demand for extensive supplies of grain, cotton, live stock, etc., and consequently

A Dipper Dredge at Work.

no demand for a great amount of farming land. America has been developing along all lines, however, and today we find an entirely different country. Population has been steadily increasing. Great cities now stand where, seventy-five years ago, there were merely trading posts. Today finds us in the age of industry—an age of iron and steel. Increased population, together with better transportation facilities and modern agricultural machinery, have made possible the working of almost all the available farm land in the country. The value of land has risen from insignificance to the very opposite, and, as men have foreseen the time when the supply

will not meet the demand, they have taken steps to utilize seemingly waste land. Thus, they have irrigated the desert and have drained the swamp.

A comparatively large proportion of the land in the valleys of the Mississippi and its tributaries were, until recently, swampy and unfit for any agricultural activity. When the problem of draining these lands was first approached, there were very few practical methods to be found, and not until the advent of heavy excavating machinery was the problem satisfactorily solved. For the most part the swamps were covered with a thick growth of timber, or, if the timber had been taken off, with stumps and underbrush. This condition demanded a machine particularly adapted to this class of work. The result was that the dipper dredge was developed and placed in operation. Its success in this field of work is well attested by the fact that more than ninety per cent of all the reclaimed swamp lands have been drained by means of the dipper dredge.

There have been attempts to dig drainage ditches with the steam shovel or the hydraulic dredge or the scraper bucket excavator, but only in a few cases, and under the most favorable circumstances, have they proven successful. The character of swamp land, in that it is either partially covered by water or extremely soft, generally precludes the use of any machinery not mounted on a barge or boat. Then again, the fact that there is usually a heavy growth of underbrush and timber, makes the dipper dredge most desirable, because of its power and ability to handle such material.

It is interesting to compare the early dipper dredge with the dredge of modern times. The early dredge, although it did the work for which it was designed, was rather a crude machine. It was equipped with the old-fashioned vertical spuds—spuds in name, more than in the service they rendered. In using these old type vertical spuds, it was necessary to construct the boat large enough to overcome the tendency to tip. In the early days drainage ditches were of small dimensions. This fact made it difficult to get a dredge of more than medium size through the ditch without excavating extra material. The extra material, of course, had to be excavated at the expense of the dredgeman. In order to overcome this difficulty, the bank spud was originated. This type of spud braced directly from either bank, giving the dredge greater stability and permitting the use of a much narrower boat. With this improvement, a dredge of larger size and capacity could be installed

without the necessity of excavating more than the required yardage to float it. These bank spuds were equipped with a racking which attached to either side of a square frame at the forward end of the boat. For the requirements of its day, the old type of bank spud served its purpose. As times advanced, however, and requirements became more rigid, the old type gave way to a more modern, simpler and more efficient design—the telescopic bank spud, connected directly from either bank to the head of the "A" frame. Provision is made for lengthening and shortening the spud by use of the telescoping device. Telescopic bank spuds have been in use several years, and have shown themselves equal to every demand made upon them. In the discussion of bank spuds, however, the fact that vertical spuds have their use must not be forgotten. In cases where the ditch is very wide and a dredge boat of sufficient dimensions can be economically installed, the modern vertical spud is a great deal more practical than the bank spud; in fact, there are circumstances under which it is entirely impossible to use bank spuds. The latest design of vertical spud differs considerably from the earlier type. They are coming, more and more, to be constructed of steel, as are also the spud casings.

One may easily recognize the early dredge by its being equipped with chains instead of cable. This was necessary because the drums and sheaves were of smaller dimensions than now. The modern dredge is almost invariably equipped with cable, due to the fact that larger drums and sheaves have been substituted for the smaller ones. The reason for such a radical change is quite apparent when one remembers that chains are extremely hard to install, are exceptionally heavy and break without warning. Cable, on the other hand, is a great deal less expensive, is clean and noiseless and much easier to install. It always gives warning before it breaks, giving the dredgeman an opportunity to prepare to install a new one with little attendant loss of time.

The practice on the modern dredge, especially the larger sizes, is to use an independent engine unit for every operation—in other words, independent swinging and spud engines. This overcomes the undesirable feature of the friction clutches that marked the early dredge. In modern times the frictions, when used, are steam-set instead of the old-fashioned hand-set type.

In the general improvement of the dredge, the trend has been toward refinement of design. Each part has been given particular study, and, as a result, the amount of iron, steel, etc., that enters

into the construction is, as nearly as possible, the amount the part demands—no more—no less. The aim has been to reduce weight—at the same time strengthening and improving the design. The more liberal use of steel, instead of cast iron, marks another great improvement. The dredge of today is practically constructed of steel throughout. The manufacturers of high grade machines maintain completely equipped laboratories where the steel, used in their product, is being constantly tested, as to strength and for defective composition. The use of manganese steel in parts subjected to great wear marks another advancement. The gear teeth are now being machine-cut instead of being cast as in the early machines. All of the engines are now throttled instead of being governor-controlled.

A great improvement in general boiler construction is noticeable as the dredge has developed. The boilers on the early dredges were designed for a pressure of one hundred ponds. A little later they were designed for a pressure of one hundred and twenty-five pounds and worked under a pressure of one hundred pounds. Today, however, the dredge boiler is usually designed for a pressure of one hundred and fifty pounds and works at a pressure of one hundred and twenty-five pounds. Improvement is very noticeable in the practice of reinforcement of the modern boiler. The method of constructing the fire door, mud-ring, etc., has undergone great changes.

A very marked improvement is noticeable in booms. As mentioned above, booms are now being equipped with cable sheaves of large diameter. A wider spread at the bottom gives them greater lateral stiffness. The yoke block, which keeps the dipper handle racking in contact with the shipper pinions, is improved by substituting rollers for the old form of sliding plate. There is a liberal use of manganese steel in parts subjected to great wear. Booms are now being built of steel as well as of wood. Under some circumstances the steel boom is of greater advantage than the wood. It can be dismantled and transported with greater ease. Modern dredge booms, both steel and wood, are generally stronger and longer lived, on account of refinement in their design, than those of the early days.

In hull construction, there has been a very noticeable advancement. As dredge machinery became heavier and more powerful and the dredge was placed under more severe strains, it became necessary to find a means, other than wood, to strengthen the hull.

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ATCHISON COUNTY MISSOURI

SHOWING DRAINAGE AND LEVEE DISTRICTS LOCATED THEREIN

Prepared by John H. Nolen Special Agt of Missouri in Land Reclamation December 1913

IOWA

MISSOURI RIVER

Nishnabotna River

North Nishnabotna Drainage District 8,000 Acres

Watson

Phelps City Drainage District 12,000 Acres

Phelps City

Rockport

Langdon

Benton Twp Dyke & Drainage Dist 5760 Acres

Nishnabotna Drainage District 12,400 Acres

Diversion Channel

Mill Creek Drainage Dist 1965 Acres

Nishnabotna

Westboro

Tarkio

Tarkio District No. 2 Contains 3875 Acres

Tarkio District No. 1 Contains 7397 Acres

Big Tarkio Drainage Dist About 6000 Acres

Fairfax

Burlington Railroad

Langdon Railroad

At first a few crude steel braces were used for this purpose, making a wood hull, partially reinforced with steel. At the present time, however, the wood hull, when used on the larger dredges, is reinforced throughout with steel, and is capable of withstanding the severest strains. Timber is not so scare as yet, nor so expensive, as to make a wood hull as costly as one of steel. The steel hull has made its appearance, however, and is waiting for the time when it can compete with the wood hull. The steel, rather than the wood hull, has the advantage, in so far as upkeep cost is concerned, for, where a coat of paint is the only necessary source of upkeep expense for the steel hull, it is often necessary to practically rebuild a wod hull. The dredgeman who, when he has finished one job, has had to knock down a wood hull, load it for shipment and rebuild it on another field, will appreciate the simplicity and advantage of steel pontoon hulls. In using a steel pontoon hull, it is possible to knock down, transport and rebuild with very little expense or loss of time. Of course, in the case of the larger dredge, it is impractical to use a pontoon hull. On the larger and more permanent classes of work the ordinary steel hull, constructed as a single unit, is very practical and economical. However, until the price of timber becomes considerably higher, and under circumstances where it is necessary to knock down the dredge at the conclusion of a comparatively small job, the wood hull has many advantages and is a great deal more economical.

It would be possible to enumerate a great many other important improvements that the dipper dredge has undergone. The number given here, however, will give the reader an idea of the progress the dredge has made and of its efficiency and economy. As in the case of land, the dipper dredge has had to undergo the change from the extensive to the intensive, both in construction and in operation. It has risen to meet a demand and has left some of the most fertile land in America to attest its success. Its work is by no means completed—it has in realty just begun. There remain yet, to be reclaimed, the great swamps of the Mississippi, the Everglades of Florida and wet lands in many other states. When the work is complete, and America is farming with the same intensity as Holland or Belgium, the dipper dredge may be forgotten. In the meantime, we must look upon it as a real factor in American progress—a beacon of the most developed political economy.

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